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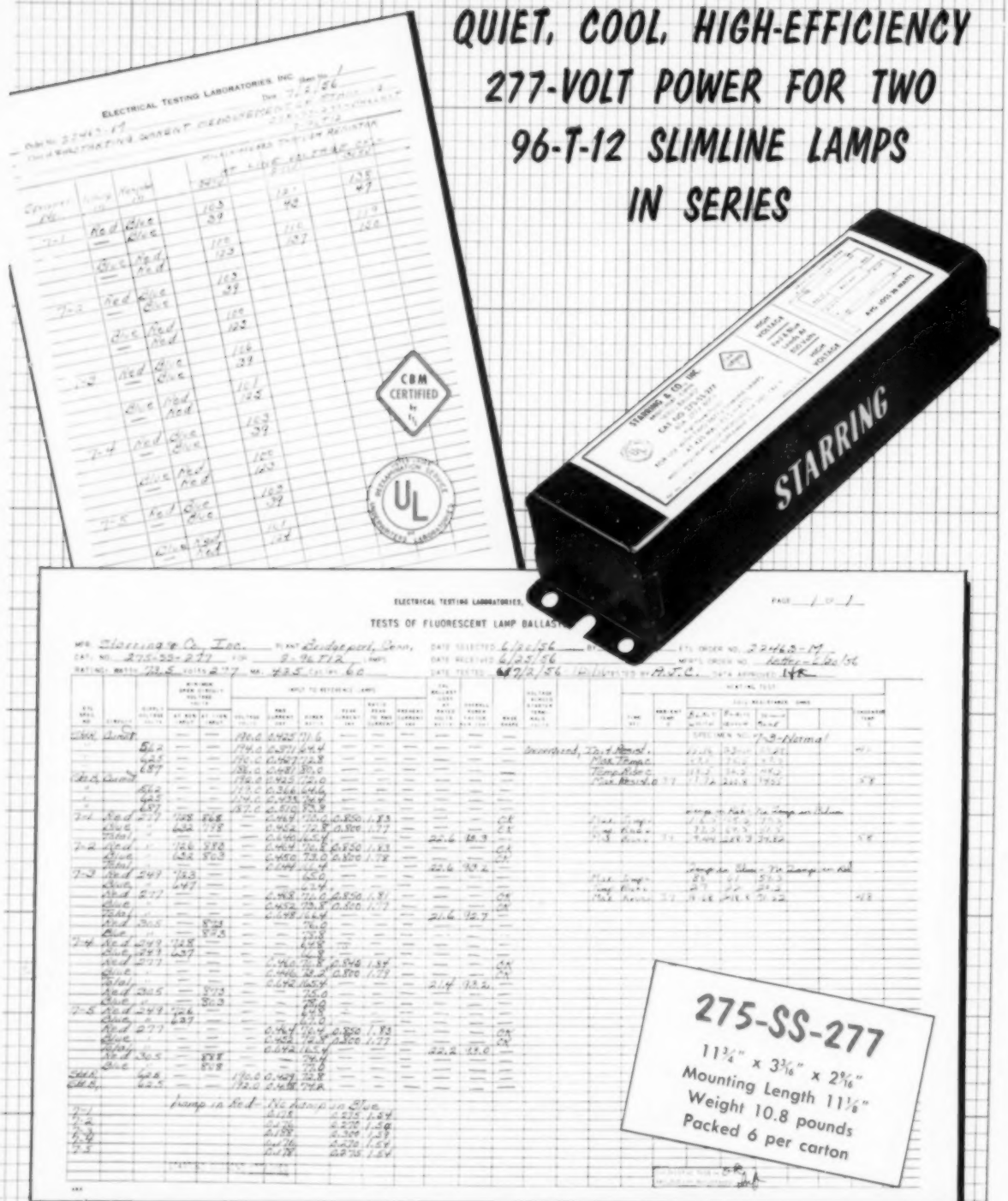

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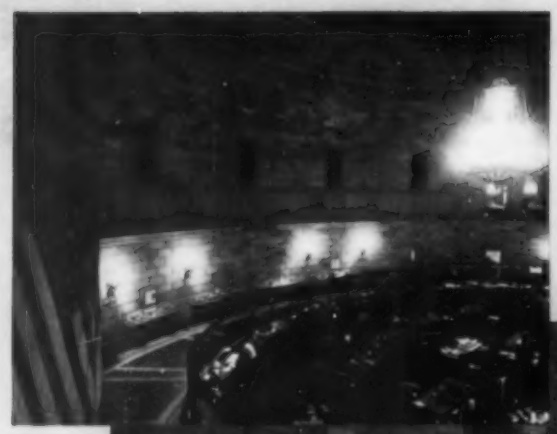

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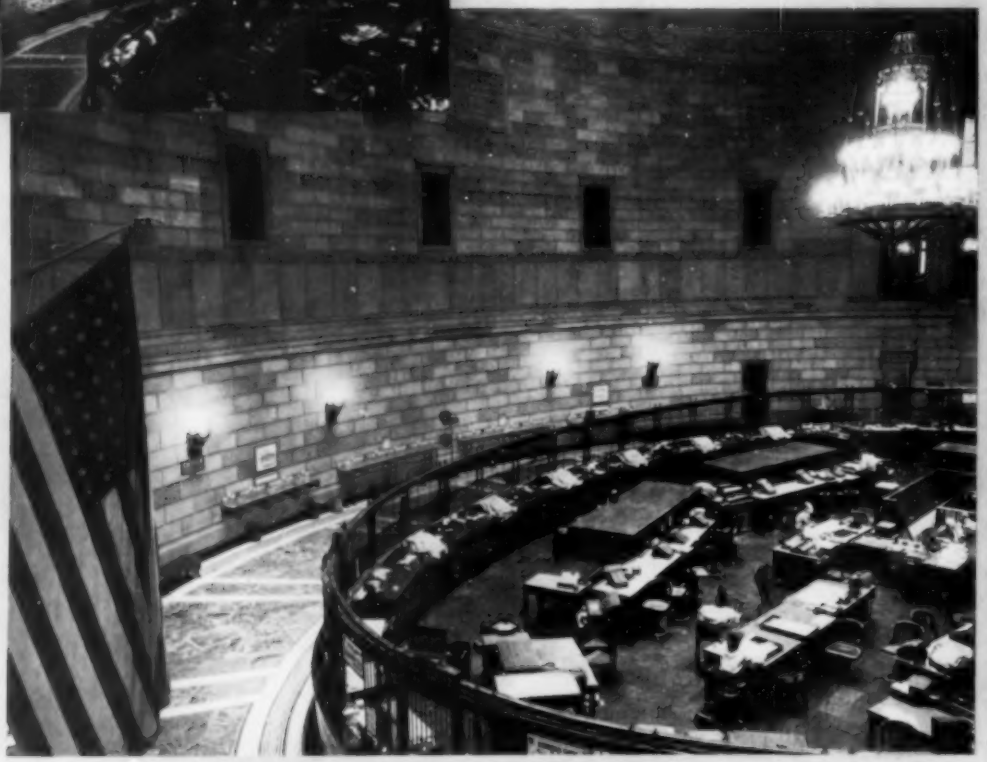

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New concepts, new combinations of standard sources and fixtures, new applications — these aspects of home lighting are discussed in this paper and the following two papers, which were presented at the I.E.S. Residence Lighting Forum last fall.

New Design Approaches To Residential Lighting

By E. W. COMMERY

At one end of residential lighting design we find the ambitions, the emotions and the comfort of people. At the other we find the structural type of the house itself. In between these two are found the characteristics of the interiors which have been created by colors, forms, textures, spaces and services. To these, lighting is applied or actually "interwoven" to meet both the functional and social requirements of living.

The greater the extremes, as expressed by the individual and the family and the structure in which they choose to live, the greater the problem; also, however, the greater the opportunity for an expanded range of lighting design. Suitability directs the selection of the kind and range of design; the same lighting design which would appear to be dull and uninteresting in a pretentious interior, for example, may be well suited to simpler decors.

These rather broad observations are set forth as a basis for studying the nature and scope of contemporary residence lighting design.

Approaching the subject more intimately, every new and untried lighting effect or equipment, and the breakdown of each of its elements, should be evaluated from a reasonable period of actual usage; off-hand judgments hastily conceived, especially while passing through exhibition rooms or new houses, are usually unreliable. Full scale living supplemented by appropriate instrumentation provides the most dependable means for basic appraisals. The designer should constantly reappraise his own work to gain experience in the cause and effect in lighting practice, and the reasons for successes or failures.

One may expect differing opinions from individuals and families for whom a lighting design is developed since they will not have the broader background of the designer. One may also expect appraisals at wide variance from the designer's intent since lay people may over-rate or under-rate both the strong and weak points of a design. The people for whom the design is intended must never be disregarded. This does not mean, however, that complete accord between the designer and the family can always be achieved at the outset. Many lighting innovations with good basic characteristics will wear well when given a chance. Confidence in good design should never be lacking.

In this paper an overall method of design approach, which is closely related to a subjective appraisal, is discussed. This is followed by a discussion of the physical forms with which essentially all lighting is designed. Finally, applications of a new proposed approach to lighting design are presented. The latter is limited to some of the simpler contemporary structural types.

Part I—Design Approach

The Illuminating Engineering Society's Recommended Practice for Residence Lighting provides a general and a detailed description of the means for providing effective lighting results for all the common living activities usually encountered in the home. Many of these are resolved in several ways,

Author: Lamp Division, General Electric Co., Cleveland, Ohio.

such as: surface fixtures and conventional floor, table and wall lamps; extended linear-source surface fixtures; built-in small area sources; built-in large area sources using fewer floor, table and wall lamps. In each, the size and type of light source is given to achieve the required quantitative results. It is proposed that present-day residential lighting plans include this ingredient, the amount of light to be obtained from the sources, whether they be incandescent filament, fluorescent, or mixtures of the two, specified in lumens. For quick orientation, today's 100-watt incandescent filament lamp supplies 1640 lumens and the improved-color warm white 40-watt fluorescent lamp supplies 1840 lumens.

Over a period of five years of design practice, my associates and I have been able to summarize the effects produced in homes using lighting design practices above, below and in strict accordance with the Society's "Residence Lighting Practice." This summarization has developed from observations in many rooms and many homes in which these practices have been properly executed. The most frequent experience has been with installations largely composed of surface-mounted fixtures, and valances and cornices in combination with floor, table and wall lamps, as used in living rooms and bedrooms.

First we have noted that it requires a minimum overall average of 70 generated lumens per square foot of floor area to meet the Society's Recommended Practice for an entire house. In a small, 1000-square-foot house the light sources, all on at one time, would generate 70,000 lumens.

It has also been noted that there is a sense of continuity and "oneness" throughout a house so lighted even though there is no similarity in the distributions of light in its rooms or a uniformity of light in any one room. In fact, there are substantial differences in the amounts of light in the various rooms, as may be noted in the table following.

The average *visual sensation level* created in the 70-lumen-per-square-foot house suggests the possibility of establishing an approximate design constant or constants, using this value as a basic minimum to provide values of illumination — such as 25 to 35 footcandles at the more important visual problem areas, and 5 to 10 footcandles as a general average throughout rooms. To achieve this visual sensation level, suitable wall, ceiling and floor reflectances and properly shaded and properly placed lighting equipments must be used.

To begin a design problem, at least on a first-go-over basis, one merely lists the square foot areas of the individual rooms. Each of these in turn is multiplied by one of the appropriate lumen-per-square-foot index values suggested in the following table.

	L.P.S.F.
Living or Family Room	80
Dining Room	45
Kitchen	80
Bedrooms	70
Baths	65
Halls	45
Utility Room Work Areas	70

A living room for example, 14 feet by 20 feet, has an area of 280 square feet. This area multiplied by the index figure of 80 suggests that the lighting design figure for this room is 19,200 generated lumens. At this point, the designer has in effect selected the amount of uncontrolled and potentially glaring light that is to be used. The design question is that of dividing, molding, shading and placing this raw and often irritating entity which, when re-combined throughout a room, provides the emotional satisfaction and functional effectiveness that makes the design worthy of the name. Since the design begins with a known value, it can end with a related value. The value in itself is not the end, however; it is at most an effective guide and starting point. None of the design prerogatives is lost, the design is more assured and realistic. Each design which ultimately becomes a real lighting installation provides another experience example for the designer to evaluate, in accordance with the client's degree of owner-satisfaction. Its visual sensation level is also a matter of design concern for further design orientation.

Certain modifications of the lumen-per-square-foot-area index values must be developed for rooms in which substantial departures from the normal lighting practices are employed. The overall luminous ceiling may, for example, be designed with an L.P.S.F. index value of 200 for kitchens and bathrooms and 125 to 150 for living and family rooms. In a room lighted entirely with recessed downlights, as another example, an L.P.S.F. factor of 70 might be used. This system is unlikely in a family living room, but special rooms could use such a system. With added experience, adjustments in the L.P.S.F. index value will be made to compensate for light- or dark-colored floors, ceilings and walls.

Later in this paper, use of this proposed design approach is demonstrated. The method does not attempt to rate the efficiency of a room's lighting. Instead it seeks to develop correlations from job to job and to create a subjective design consciousness and then a control over the design which can re-

move much of the uncertainty that prevails in today's residential lighting designing.

Its screening value is also of great importance since the predetermined amounts of light will be provided by the selected light sources regardless of what the design may be. In this way the overrated or erroneously conceived design is discovered, since it simply lacks the first necessity for success, light itself. With a designed performance capacity, light, like the heating of a home, can be made to serve the requirements of family living with exactness, purposefulness and finesse.

Part II—Physical Forms

The second factor of design procedure covers the basic physical forms of the lighting elements. The diversity of available forms and the problems of accumulating related technical data point out the need for at least an approximate method of classification. Of even greater value would be indications of their performance compatibility, one with another, and their subjective and objective performance effectiveness.

At the outset, the designer may choose to have the lighting elements clearly evident or mainly concealed. In most cases, the installation will not use either type exclusively, since both have their good points and disadvantages. Mixtures of the two types, like mixtures of personality characteristics, temper the qualities of each and expand their individual potentials. Just as we need light and shade to give depth and life to the final effects, we may find that the "all-apparent" system of lighting may overplay itself and the completely concealed, all-diffuse system may be overbland. The broadly distributed system of light from concealed sources needs only small amounts of evident or apparent light to provide the illusion that the evident part is doing far more of the job than it really is. This is a fortunate circumstance, which should be planned for more often. The opposite is usually the case, leading to dismal, harsh and unfriendly interiors. A twinkling group of low-wattage lamps (15 watts each) when checked against the L.P.S.F. index method supplies only a small fraction of the overall light. Ten 15-watt lamps, unshaded or shaded, can in themselves provide a fascinating effect for a special occasion, but the gloom that develops after a short experience with the room which they are lighting leaves much to be desired. This can be expected since such a fixture, for example, in a 14 by 14-foot dining room results in an L.P.S.F. index value of 7.2, or approximately one-sixth the suggested target value. The room needs fill-in lighting of the unobvious type, and how far

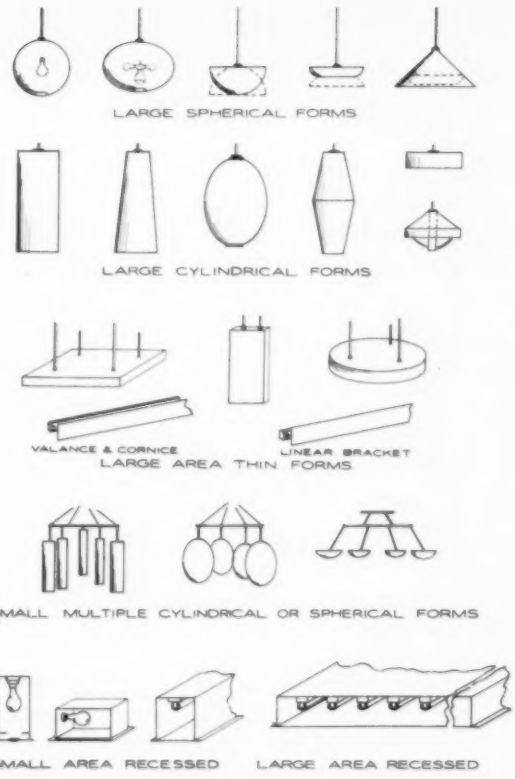


Figure 1. Typical residential lighting fixture forms.

toward the target value we go with fill-in light will depend upon the complete resume of all the services the room may have to render. As the list of family services expands, the need for higher L.P.S.F. values becomes more insistent.

This example of extremes serves to orient this part of the discussion. The extremes range from dullness to scintillation; this palette has a greater range than is obtainable from any single medium of design especially when modifications of color of light are added. This is never very clear until the completed work is seen in action in the client's home. Even then, it should be appraised with a full complement of people in the spaces.

The size, shape, extent and placement of the lighting devices control every aspect of the subjective qualities of the design, regardless of how efficient or functionally sound the design may be. This, in itself, points to the importance of the lighting equipment forms.

The basic geometric solid forms and two-dimensional surfaces are fundamental. They were the earliest (after the candle or flame holder) and are still widely-used lighting equipment forms. They begin with the sphere, the hemisphere or open bowl

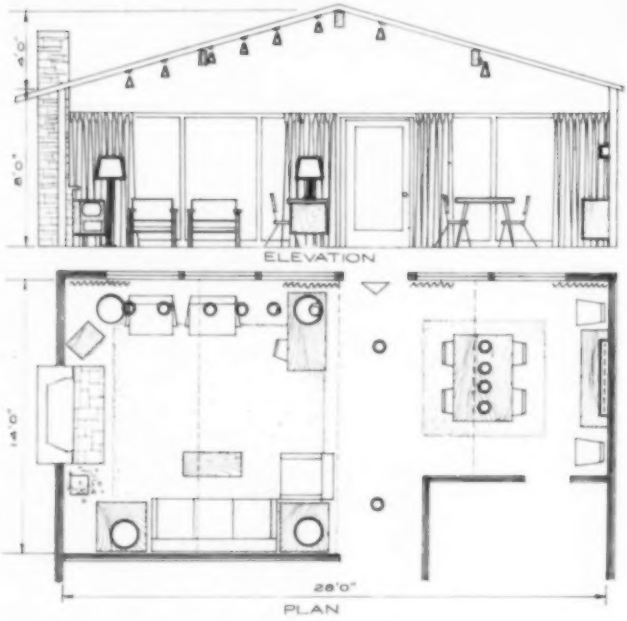
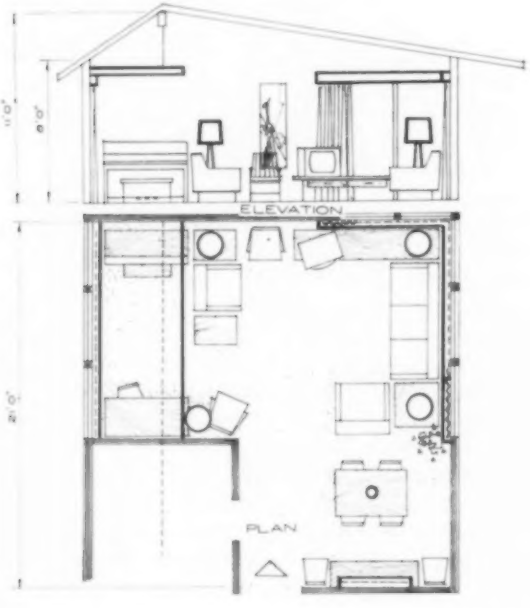


Figure 2 (left). Total floor area — 354 square feet (23,922 lumens).
Living room — 196 square feet.
Four 150-watt table lamps, 43.4 L.P.S.F.
Six 75-watt wall lights, 35.2 L.P.S.F.
Total, 78.6 L.P.S.F.
Passageway — 63 square feet.
Two 150-watt downlights, 56.5 L.P.S.F.
Dining area — 95 square feet.
Four 30-watt downlights, 8.4 L.P.S.F.
One 40-watt fluorescent bracket, 18.4 L.P.S.F.
Two 75-watt wall lights, 24.2 L.P.S.F.
Average, 67.5 L.P.S.F.

Figure 3 (below). Total floor area — 337 square feet (25,250 lumens).
Living room — 240 square feet.
Three 30-watt in fluorescent valance, 23.1 L.P.S.F.
Three 20-watt in fluorescent valance, 8.6 L.P.S.F.
Three 40-watt in fluorescent shelf lighting, 23.1 L.P.S.F.
Four 150-watt table and floor lamps, 35.5 L.P.S.F.
Total, 90.3 L.P.S.F.
Dining room — 97 square feet
One 40-watt fluorescent wall bracket, 19.1 L.P.S.F.
One 150-watt reflector downlight, 18.4 L.P.S.F.
Average, 75 L.P.S.F.



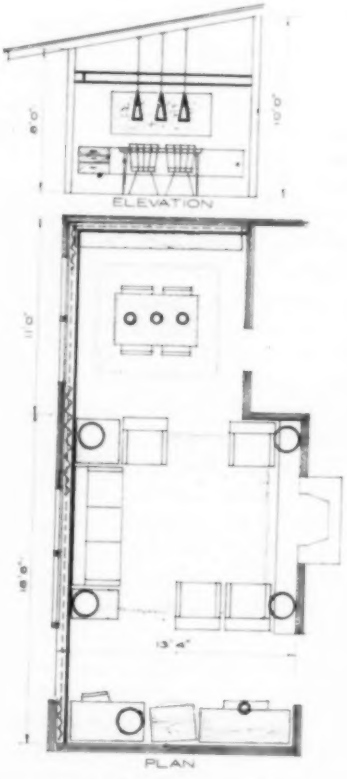


Figure 4 (above). Total floor area — 356 square feet (30,438 lumens).
Living room — 246 square feet.
Five 150-watt table lamps, 43.4 L.P.S.F.
Four 40-watt fluorescent in valance, 30.0 L.P.S.F.
One 150-watt reflector downlight, 7.3 L.P.S.F.
Total, 80.7 L.P.S.F.
Dining area — 110 square feet.
Three 40-watt fluorescent in valance, 50.0 L.P.S.F.
Two 40-watt fluorescent in bracket, 33.5 L.P.S.F.
Three 40-watt incandescent in fixtures, 12.6 L.P.S.F.
Average, 85.5 L.P.S.F.

(deep or shallow) and the cylinder. Recently the latter has been modified with outward curving and multiplane sides. The cube is also used. Over the years the maximum diameter and depths of these forms have been increasing. Today lightweight plasties make it possible to provide spheres with diameters of over 48 inches. This new size provides scale importance to the whole "family" of forms, which they never enjoyed when they were limited to diameters of 8, 10, 12 and 16 inches or depths of 12 to 16 inches (see "Large Spherical and Cylindrical Forms" in Fig. 1). For example, a large 26-inch white plastic sphere can handle 2650 lumens, with a 150-watt lamp. Special versions of the larger full- and half-spherical and cylindrical forms, equipped with reflector type lamps, can provide substantial additional downlight through bottom openings. This light need not increase the brightness of the diffusing form.

Glass of greater softness and beauty is appearing now — often grouped in circles, ovals and irregular arrays. Clusters of these pieces are also arranged at random heights (see "Small Multiple Cylindrical or Spherical Forms" in Fig. 1). Their self-evident qualities naturally draw attention to them and unless their brightness is kept low they can be distracting and annoying. Their inherent gaiety and loveliness should always be preserved, by not asking them to provide too large a part of the lighting. A six-light type using 40-watt lamps (465 lumens each) handles 2790 lumens. These same forms can also be used in metal with piercings. The effects produced are more controllable, but depending on the type can result in either high contrasts or dullness. The open-bottom types are contrasting and the open top types are duller. Combinations of opaque-sided open-top-and-bottom forms can supply both qualities, together or separately, through multiple lamping and switching. Generous spacing between individual diffusers or shields spreads the light and provides softness for the direct-view visual impact.

Thin solid forms, round, square and rectangular, have recently been developed for both suspension hanging and surface mounting (see "Large Area Thin Forms in Fig. 1). The thinness of these is made possible by the small tube diameter of both the straight and the circular fluorescent lamps. Where ceiling height permits, especially in the open rafter and beam construction living rooms and family rooms, these types offer a new range of design effects. They can with good shielding such as fine plastic or metal honeycomb, handle generous amounts of light, both upward and downward, with less evidence than is possible with the geometric forms previously discussed. This is the form from which the designer may expect to develop a newer apparent light effect with the least amount of distraction.

Every member of the "equipment family" of the large-area thin forms handles larger amounts of light with greater ease than do the other forms. This does not suggest that they should generally be used in preference to the other forms; each has its own characteristics. Fundamentally, well-shielded large-area forms distribute light easily and broadly and can, therefore, be counted on to make substantial contributions when the lumen score for a room is being summarized. Upon first examination they may appear to be useful only for general room lighting. Actually they can be located above and behind particular areas requiring localized lighting just as we locate narrow-beam spots and floods. Of course the large-area source provides its own surround light as well as providing the greatly softened broad localized light.

The subject of diffusing materials for large-area fixtures and their positioning and shielding takes on more importance in the home since, as is usually the case, the physical distance between the individual and the light-giving areas is much less than in many commercial interiors. Then too, judgment is made by different standards — the client in the home being more critical.

A fully developed statement covering the characteristics of all the basic fixture forms would go beyond the original intent of this discussion. Hence, only the first elementary phases are included. In addition to the forms themselves, much has to be known about the light-diffusing, light-controlling and light-coloring properties of the materials used to make the fixtures, since the basic form alone, without dimensions, may not always provide the necessary information. The form families, however, may usually be used for practical approximations of what may be expected when they are installed. The classification of lighting equipments by their forms needs to be supplemented by observation in actual rooms, of sizes and types similar to those in which their use is being considered. Examples may be found in many places; however, a full range of all types, well applied, does not abound in any one locality. They are all currently manufactured in a wide range of styles.

It should be remembered that the forms which present the largest areas directly toward you when you are seated more than four feet from the fixture, should be lower in brightness. This is accomplished by increasing the size of the unit for a given amount of light, or by using a denser or more nearly opaque diffusing material. Opaque material

Figures 5 and 6. Family room — 490 square feet, 14 by 35 feet with 13-foot ceiling, using large area thin fixtures. Living end (left): eight 40-watt fluorescent lamps over area rug; two 150-watt three-light lamps; 77.4 L.P.S.F. Dining end (right): four 40-watt fluorescent lamps; two 20-watt fluorescent lamps; nine 100-watt colored tinted lamps; one 150-watt lamp, 74.7 L.P.S.F.

eliminates some of the direct viewing problems of brightness. However, its use does not answer all the design problems.

Any broad discussion of lighting design will usually reveal the varieties of methods which may be employed, especially when the home being considered has studied and developed architectural qualities. Today we are fitting lighting mechanics into homes with greater ease than ever before, although this fitting results only when the lighting designer accepts the full responsibility for specifying every detail of the design. Nothing should be left to other specialists to resolve. The time will come when this responsibility and constant follow-up will not be necessary. At present everything, to the small details, must be watched.

Part III—Applications

Examples of three living-dining rooms with different open-beam ceilings and their floor plans demonstrate some of the ideas discussed in the first two parts of this paper. They are shown in Figs. 2, 3 and 4. Their floor areas are similar, averaging 349 square feet. A larger open-rafter family room of 490 square feet is presented in two parts, in Figs. 5 and 6. Selections from a recently completed home with plaster ceilings are shown in Figs. 7, 8, 9, 10 and 11. Total enclosed living space in this house is 4100 square feet.

The elevation and floor plan in Fig. 2 show the span of 28 feet with ceiling divided equally on either side of a central ridge beam. One-half the area is devoted to the living room furniture; a central passageway, a dining table, chairs and server occupy the remainder. The total of 23,922 lumens is generated by the lamps in the equipments which serve the entire plan. While the different parts of the total space vary in their requirements, the minimum target value of 70 L.P.S.F. is only missed by 858 lumens.

The offset ceiling ridge beam (Fig. 3) affords an entirely different furniture and lighting plan. The desk and piano are placed at opposite sides of one end of the room and a sofa and four-chair group are across from them. The suspended luminous ceiling section over the desk and piano conceals three improved-color warm white fluorescent lamps. The opposite end of the room carries 18 feet of fluorescent lamps. The dining area is equipped with a four-foot fluorescent bracket over the server and a 150-watt reflector lamp over the table. Average L.P.S.F. for both rooms is 75. The living room by itself is 89.8 and the dining room is 37.5.

A plain slanted ceiling, 29½ feet across, covers the living-dining room in Fig. 4. The 28 feet of valance lighting provide the basic wall wash along the entire outer wall. Four table lamps balance the center symmetrical furniture grouping and a fifth table lamp is on the desk. One ceiling downlight over the piano and three tapered drop lights over the dining table complete the design, at 85.5 L.P.S.F.

Figs. 5 and 6 show the use of thin floating panels over the fireplace grouping and the desk. The 60- by 60-inch fireplace panel contains eight 40-watt fluorescent lamps. The 60- by 45-inch over-desk panel contains four 40-watt and two 20-watt lamps.

Figure 7. Modern architecture and modern lighting blend to create new orders of livableness. This view conveys some of the qualities that can give today's homes variety and continuity. The 4100 square feet of enclosed living space is served by lighting which totals 15 kw.

Three 24-inch circular panels over the dining table each contain nine tinted incandescent filament lamps, three each of three tints — yellow, blue and pink. A separate color choice may be selected from each of the disks. Both the square and circular floating panels use fine metal honeycomb bottom shields. Both upward and downward light is supplied by these forms. Lighting at the two ends of the room can be balanced, if desired, since the generated light in each half is about equal, 74.7 and 77.4 L.P.S.F. Broad accents spring from the large area panels, which may be dimmer controlled for varying uses of the room. The tinted light at one end blends smoothly into the improved-color warm white fluorescent light at the other end of the room.

Larger homes, which are carefully designed and skillfully decorated offer the ultimate in bringing about a high order of coordination between architecture, decoration, lighting and family objectives. This coordination develops most favorably when the lighting designer is a part of a planning group, which includes the family. Fitting the mechanics of lighting into the structure, while purely objective, must be specified and supervised by the lighting designer. This is a role that is not widely recognized in residential work. However, until such time as the use of more advanced lighting

Figure 8. Ceiling height of 10 feet 6½ inches and generous room size permit wall cornices of larger than usual dimensions in this living room. Drawing below shows cross-section through drapery-fireplace wall.

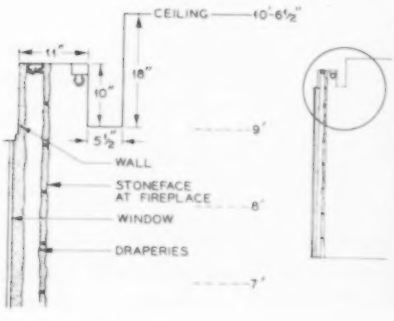
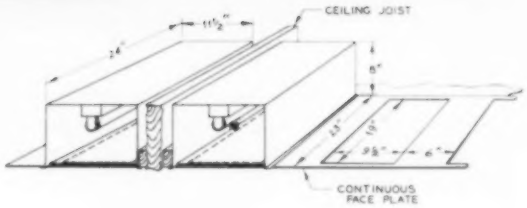


Figure 9. Two controlled banks of recessed panels are on dimmer, providing flexibility to create and alter the room atmosphere, in a den lounge. Drawing below shows dimensions of panels.

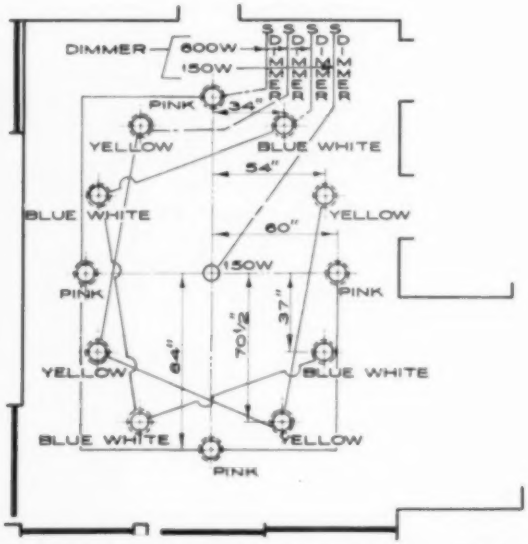


techniques is better understood by everyone on the construction side of the job, the lighting designer must be on all sides of the work.

Figs. 7 through 11 are photographs of a recently finished home for which the desired high order of cooperation was developed. In this case, the lighting is closely integrated with the plan of living and with the structure. It will be recalled that these are the two extremes of design set forth at the beginning of this discussion.

There are several starting points from which appropriate and imaginative use of light can be developed. Some of these are family habits, special viewing problems arising, for example, from large

Figure 10. Twelve recessed reflector lamps, in pink, gold and blue-white, are on dimmer control, and may be variously combined. Drawing at right shows lighting layout of dining room ceiling.



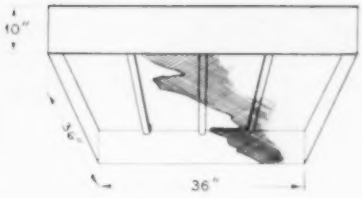


Figure 11. Drawing above shows large area unit flush-mounted in bedroom. Table lamps supply over-shoulder lighting for reading or hand-sewing in arm-chairs.

glass areas with night views, room arrangements and structural characteristics. Luminous qualities should be sought throughout, with room to room continuity but with no slavish adherence to any one principle. Changes of pace should occur without undue dramatics.

Fig. 7 shows the exterior and indicates the extensive glass area through which magnificent views of a great city and ocean are visible. Well-shielded downlights control light and prevent it from striking the vertical surfaces, thereby avoiding reflections in these glass areas. When the view is unimportant, or the weather inclement, the long walls are washed with light. Prismatic glass surface plates in the overhangs keep unwanted light on the outside of the house and along the surrounding terraces. Throughout the house, the selection of materials and finishes complements the planned lighting. The carpeting in this home is a light neutral gray, the walls off-white and the wood trim, black. The interior lighting totals 15 kilowatts; five kilowatts supply the exterior lighting. The connected lighting load is divided 25 per cent improved-color-warm white fluorescent, 49 per cent incandescent reflector lamps and 26 per cent inside frosted lamps. The interior lighting for the entire house generates 68 lumens per square foot.

The ceiling height of 10 feet 6½ inches, and the generous room size permit wall cornices of new and greater dimensions as shown in Fig. 8. Instead of being a board applied to the ceiling, this member, which is 5½ inches thick and 18 inches deep, becomes structural. Under dimmer control, the fluorescent lamps, always improved-color warm white, provide a substantial control of the luminous environment. These surfaces are directly opposite the extensive window wall. On high, the cornice lighting provides stimulating brilliance, on low, quiet intimacy.

Fig. 9 shows two controlled bands of recessed panels each using one 20-watt fluorescent lamp providing flexibility to create and alter atmosphere. Dimmed to the lowest levels, the panels take on the appearance of being openings into the sky.

In the dining room (Fig. 10), twelve recessed color reflector lamps form pink, gold or blue-white atmospheres. In the center, the symbolic and decorative chandelier satisfies the eye and tradition as a focal point. Each tint is under dimmer control. Proper mixtures of the three provide white light.

Fig. 11 shows the master bedroom where large area flush units shield fluorescent lamps with fine honeycomb metal louvers. Three 25-watt lamps are in each. Soft over-shoulder lighting is supplied for reading or hand sewing in each chair.

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Luminous Ceilings With Incandescent Lamps

By DOMINA EBERLE SPENCER

DURING the last decade luminous ceilings have found wide application in offices, drafting rooms, classrooms and commercial establishments. But luminous ceilings in homes are still quite rare. What are some of the reasons for this difference?

Hitherto, detailed methods have been worked out for the design of luminous ceilings for strictly utilitarian applications. To provide the optimum luminous environment we satisfy the 3:1 adaptation helios (brightness) ratio by using high reflectances, suitable lamp spacings, and all the light we can afford. The result is a delightful luminous environment with excellent visual conditions throughout the room.

The design of luminous environments for the home is an even more complex problem. The result must be *both* utilitarian and decorative. The lighting should not only promote effortless vision; it should also be decorative, and should, in some rooms, allow the creation of many moods. Thus, color, pattern, and flexibility become important. In addition, luminous ceilings used in one room must be correlated with other types of lighting in adjacent rooms and must frequently be tucked into negligible spaces between the beams.

This paper will show that, whereas fluorescent lamps are preferable for the high-level utilitarian luminous ceiling, incandescent lamps may often be preferred for luminous ceilings in the home. Application will be made to luminous ceilings in both traditional and modern homes.

Why Incandescent Lamps?

Incandescent lamps differ from fluorescent lamps in three principal respects:

(1) The *color* is warmer than that of fluorescent lamps and is free from the distortions associated with the mercury-line spectrum.

(2) Incandescent lamps produce less lumens per watt than fluorescent lamps.

(3) When incandescent lamps are dimmed, the color changes markedly, giving an effect that shifts from sunlight to firelight.

It will now be shown that all of these differences may be construed as advantages in the peculiar problem of home lighting.

Incandescent lamps radiate a continuous spectrum which is much stronger in the red than in the blue. As compared to daylight, which is more evenly distributed throughout the visible region, incandescent light distorts the colors of objects seen under it by reinforcing the warm yellows and reds and fading the blues. Under incandescent light, the natural gold of blonde hair is enhanced, while navy blue looks almost black. This distortion is, however, generally regarded as an acceptable one with attractive psychological connotations of warmth and security.

The radiation from fluorescent lamps contains two components: a continuous spectrum from the phosphors and the characteristic line-spectrum of mercury. By suitable combination of phosphors, the continuous component of the fluorescent spectrum can be made satisfactory. However, as long as the line spectrum is present, there is a distorting tendency that emphasizes the yellow-green. This type of color distortion is particularly unbecoming to the human skin, to blonde hair, and to many food products, and has unpleasant psychological connotations. While these distortions may often be regarded as unimportant in utilitarian designs, they become very important in home lighting.

If a single color of light source is used throughout the home, the eye becomes adapted to it and color distortions are minimized. Thus, there is an advantage to correlating the color of the light in adjacent rooms of a house. If conventional incandescent luminaires are employed in some rooms and the luminous ceiling is used in only one or two rooms, incandescent lamps should be used also with the luminous ceiling. Even the warmer tone fluorescent lamps which have been specially designed to "match" incandescent, do not provide a satisfactory match. People move from one room to another frequently in a home, so correlation of the color of the light in adjacent rooms is even more important than in offices or factories.

Correlation of quantity of the light in adjacent

A paper presented at the Residence Lighting Forum of the National Technical Conference of the Illuminating Engineering Society, Sept. 9-13, 1957, Atlanta, Ga.

AUTHOR: Associate Professor, University of Connecticut, Storrs, Conn.; Consultant, Marlux Corp.

Figure 1. House of traditional architecture.

rooms is likewise important so that major readaptation is not required as one goes from room to room. Preferably the adaptation brightness in adjacent rooms should not vary by more than 3:1, certainly not by more than 10:1. As the general level of illumination in rooms lighted by commercially available luminaires is seldom more than 5 to 10 footcandles, luminous ceilings should provide about 30 footcandles when close work is to be done, with considerable interest in lower levels for special purposes.

If new homes are planned with built-in luminous ceilings, adequate space can, of course, be provided. But if luminous ceilings are installed in existing homes, it is important that they be as shallow as possible in order not to damage the architectural effect. The shallower the luminous ceiling, the closer must be the lamp spacing. The closer the lamp spacing, the larger the quantity of light. Thus shallow luminous ceilings tend to be associated with large quantities of light. With fluorescent lamps, even 120 ma slimlines, it is difficult to design a shallow luminous ceiling that will give less than 50 footcandles. With incandescent lamps, the number of lumens per unit area can be reduced below this level without requiring undue space.

While it remains true that visual conditions for work are better at high levels than at low, there are many times when rooms in homes are not used primarily for visual work. For listening to music, for relaxation, for conversation, for entertaining, it may be quite desirable to dim the luminous ceiling from 30 footcandles to even as low as one footcandle. Dimming of fluorescent lamps is today possible, but it is not within every home budget. Dimming of incandescent lamps has the twin advantages of economy and complete change of mood. As the incandescent lamps are dimmed, both the quantity of the light and the color vary. At the lowest levels, the room is lighted by a diffuse ruddy glow; the atmosphere is intimate, reminiscent of firelight. As the quantity of light increases, the effect becomes that of twilight, then that of a bright cloudy day, and finally at the top of the range a wonderful sunlit yet glareless room.

Which Incandescent Lamp?

By the limitations of shallow luminous ceilings and comparatively small quantities of light, we are required to use small sizes of incandescent lamps. But standard 120-volt lamps of 15 or 25 watts give only about half as many lumens per watt as 100-watt lamps (Table I). However, lamps designed for lower voltages than 120 are more efficient. It would be possible to use two 60-volt lamps in series, four 30-volt lamps in series, or ten 12-volt lamps in series. The lower the voltage the more lumens per watt. This advantage must be balanced against the nuisance of replacing burned-out series lamps. Twelve-volt lamps are not greatly superior to 30-volt in efficiency but are much more nuisance, so the choice falls on series-parallel groups of 30-volt lamps. Table I shows that the use of these lamps (listed under train and country-home lighting) provides a saving of 32 per cent for 25-watt lamps and 28 per cent for 15-watt lamps as compared with 120-volt lamps.

Each time a single lamp burns out, a group of four fail to light. But a single opening in the luminous ceiling will generally permit access to all four lamps. The annoyance will be still less if lamp life is increased by operating the lamps below rated voltage on a dimming circuit part of the time. With normal use at full voltage, lamp replacement should be required about once a year. If desired, this can be combined with yearly washing of the plastic and with group lamp replacement.

Renovating a Traditional House

The conclusions described in the foregoing sections were drawn in the course of designing luminous ceilings for my sister's home in Washington, D. C. The house, of traditional architecture, white brick, with brown wood trim and a sloping roof of Vermont slate, nestles in a grove of 58 trees on the edge of the District of Columbia, a few blocks off Massachusetts Avenue (Fig. 1).

Luminous ceilings were planned for the living room and kitchen, while luminous indirect luminaires of the Magna type were installed in the bedrooms (10 footcandles) and a cut-glass chandelier giving 5 footcandles was hung over the dining room table.

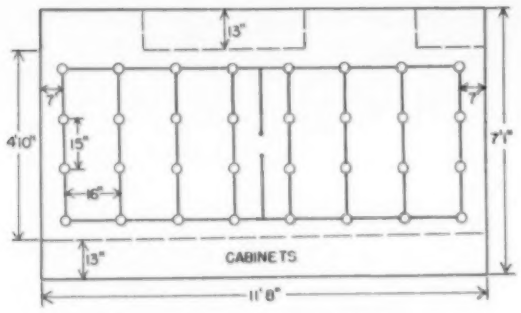


Figure 2. Dimensions of kitchen.

TABLE I — Characteristics of Incandescent Lamps.

Power	120-Volt F_L (lumen)	120-Volt η (lumen/watt)	30-Volt F_L (lumen)	30-Volt η (lumen/watt)	Percent Saving with 30-Volt Lamps
15	141	9.4	179	12.0	27.6%
25	265	10.6	350	14.0	32.1%
50	660	13.2	810	16.2	22.8%
100	1630	16.3	1850	18.5	13.5%

TABLE II — Room Characteristics.

	Kitchen	Living Room
Length	11'8"	28'
Width	7'1" (4'10" unobstructed)	14'
Height to plastic	7'1"	9'
Height above plastic	1'1"	1'
Domance, k_r for room	1.038	0.482
Domance, k_r' for luminous ceiling	0.158 ($h'=1'$, $w'=1'1"$, $l'=14'$)	0.464
Floor area, S	82.8 ft²	392 ft²
Wall reflectance, ρ_1	0.7	0.8
Ceiling reflectance, ρ_2	0.7	0.7
Reflectance above plastic	0.8	0.8
Floor reflectance, ρ_3	0.3	0.1
Interflectance, f	0.546	0.853
Logance, g	0.642	0.427
Coefficient of utilization	0.350	0.364

The first step was the kitchen. As shown in Table II and Fig. 2, the kitchen is 11 ft 8 inches long by 7 ft 1 inch wide. However, white cabinets line the room on both sides over most of its length, making the effective width for lighting calculations only 4 ft 10 inches. The original height of the plastered ceiling was 8 ft 2 inches. Without obstructing cabinet doors or windows, this could be lowered 13 inches to 7 ft 1 inch. Since k_r for the room is high, 1.038, in spite of white walls and stippled white floor tile, the interflectance is only 0.546. However, as the space above the plastic is unobstructed and all surfaces are painted white, its domance (index of room proportion) is low, $k_r' = 0.158$, and the logance (efficiency) of the luminous ceiling is consequently high, $q = 0.642$. The calculated coefficient of utilization is 0.350.

Table III shows the quantities of light that would result with three choices of lamps. For uniformity with a depth of 13 inches above the plastic, lamps were placed on 15-inch to 16-inch centers as shown in Fig. 2. (As the center of the incandescent lamps is about 3 inches below the ceiling, the distance from lamp center to plastic is thus 10 inches. If the uniformity criterion is that lamp spacing be 1.5 times the distance from plastic to lamp center, this would give a spacing of 15 inches.) Thus we need either eight 4-foot fluorescent lamps or 32 incandescent lamps. With fluorescent lamps, 88.0 footcandles would be obtained with 5.32 watts per square foot. Even with the relatively efficient 30-volt incandescent lamps only 47.3 footcandles are obtained with 9.67 watt per square foot.

The incandescent lamps were chosen because of their better color rendition of both vegetables and my sister's blonde hair. Other advantages were the low initial cost of the equipment, ease of installa-

TABLE III — Choice of Lamp.

Lamp	Number required for uniformity	F_L (lumen)	η (lumen/watt)	P (watt)	D_{AP} (footcandles)	P/S (watts per square foot)
KITCHEN						
Instant start fluorescent 40-watt, T-12, 48"	8	2.08×10^3	47.3	440	88.0	5.32
25-watt, 120-volt incandescent	32	8.48×10^3	10.6	800	35.8	9.67
25-watt, 30-volt incandescent	32	1.12×10^4	14.0	800	47.3	9.67
LIVING ROOM						
Instant start fluorescent 40-watt, T-12, 48"	52	1.35×10^5	47.3	2860	125.2	7.30
15-watt, 120-volt incandescent	208	2.93×10^4	9.4	3120	27.2	7.97
15-watt, 30-volt incandescent	208	3.72×10^4	12.0	3120	34.6	7.97

Figure 3. Luminous ceiling installed in kitchen.

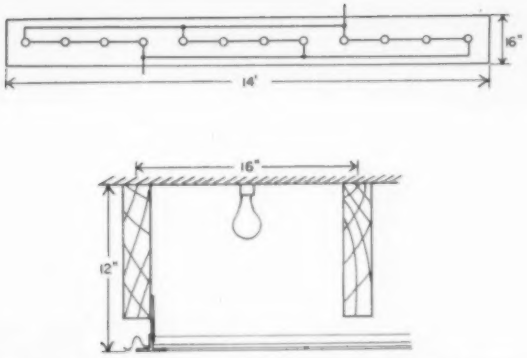


Figure 4. Living room. Lamps installed between beams.

tion, and the matching color of illuminants in kitchen and dining room. Even with the incandescent lamps there is about ten times as much light in the kitchen as in the dining room. So great is the contrast that the electric candles in the dining-room chandelier seem almost the dim flickering candles of our forefathers.

Fig. 3 and Table IV show the resulting distribution. Adaptation helios ratios are below 3. About 50 footcandles are incident on the major part of the work area. The first and only lamp failure so far occurred one year and three days after the installation was completed. Comparative temperature readings have been measured above and below the plastic. The temperature difference is between 4 and 8°F. It should be noted that this temperature differential contains both the effect of heating from 800 watts of incandescent lamps above the plastic and the effect of heat rising from the stove after an extended period of cooking.

Once the kitchen had been successfully completed, the next project was a luminous ceiling for the spacious 28 ft by 14 ft living room. Here the original ceiling height was 9 ft 3 inches with 1 ft 11 inches above the windows. My sister wanted a luminous ceiling in the living room but she did not want to lose a single inch from the ceiling height. Desired, one luminous ceiling of zero thickness! Unfortunately, electroluminescent luminous ceilings are not yet practicable. Luminous ceilings that can be built today are of finite thickness. After considerable deliberation we decided to find space for the luminous ceiling by removing the plaster ceiling, the lathe beneath and tucking the luminous ceiling up between the beams. The space thus located is indicated in Fig. 4. The resulting luminous ceiling was hung only 3 inches below the bottom of the beams. Major disadvantages of this procedure are the difficulties of plaster removal, the numerous coats of paint required to give the beams a glossy coat of white, and the inescapable fact that the resulting ceiling is subdivided into many inefficient compartments. There are 18 principal compartments formed by the beams: thus the domance k_r' is only 0.464 in the living room and the logance only 0.427. Over half of the light from the lamps is trapped among beams, strapping, electric conduit and water pipes. While the large room is comparatively efficient with an interflectance of 0.853, the obstructions in the luminous ceiling trap so much light that the coefficient of utilization is only slightly higher than that in the kitchen.

The number of lamps needed to make the ceiling appear uniform is 208, Fig. 4. In each section between adjacent pairs of beams, lamps are arranged in three series-parallel groups of four. In order to keep the current taken by this luminous ceiling

TABLE IV — Measured Distribution of Light.

	Kitchen	Living Room
Incident on work (footcandles)	53	34
Wall (footlambert)	35	19
Ceiling (footlambert)	115	52
Floor (footlambert)	21	7
Work (footlambert)	42	27
Adaptation ratios with respect to work		
wall	1.2	1.4
ceiling	2.7	1.9
floor	2.0	3.9

Figure 5. Living room with luminous ceiling. Translucent plastic rails hang from alternate beams, dividing the ceiling into 45 panels.

below 30 amperes, 15-watt, 30-volt incandescent lamps were used. As shown in Table III, the quantity of light is then 34.6 footcandles with 7.97 watts per square foot and the total power of 3.12 kw.

The adaptation helios ratios for the wall and ceiling (Table IV) are both below 2. That for the floor is 3.9. The appearance of the luminous ceiling as viewed from beneath is shown in Fig. 5. Translucent plastic rails hang from alternate beams and subdivide the ceiling into 45 panels which are approximately square. At present, corrugated vinyl panels are arranged with opposite directions of corrugations in adjacent panels. This gives an attractive pattern. There is also the possibility of replacing a few of these by stained glass or other types of panel, decorated in color. If the area of the colored panels is kept small in comparison with the whole, the visual characteristics of the luminous ceiling will not be harmed seriously and the aesthetic effect may be enhanced.

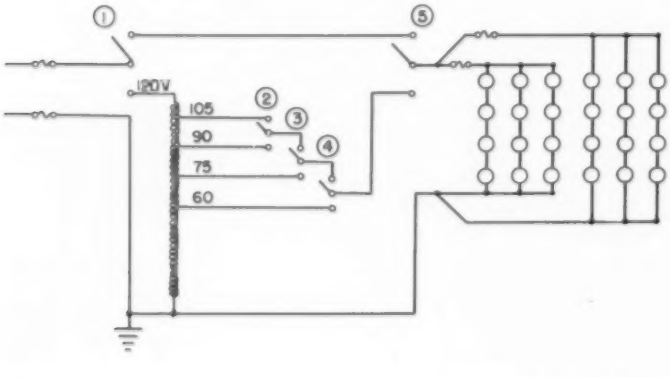
Dimming Circuit

To provide added variety and interest, we decided to provide a method of dimming the lights in the living room. Commercial methods of continuous dimming were at first considered but were discarded because of high cost and extreme complexity. Simple commercial dimming equipment is only available in very small sizes, designed for dimming a single incandescent luminaire. After some study, it was concluded that the continuous feature of the dimming was unessential. The important thing was to have the possibility of a number of different levels. Five voltages were chosen: 120, 115, 90, 75 and 60. A simple autotransformer, designed for the rated load of the 208 lamps, provided the desired voltages.

An unexpected stumbling block was the switch. When the current rating is as high as 30 amperes,

Figure 6 (below). Circuit diagram for living room installation.

Figure 7 (right). Key to switching for living room. Five levels of illumination are available.



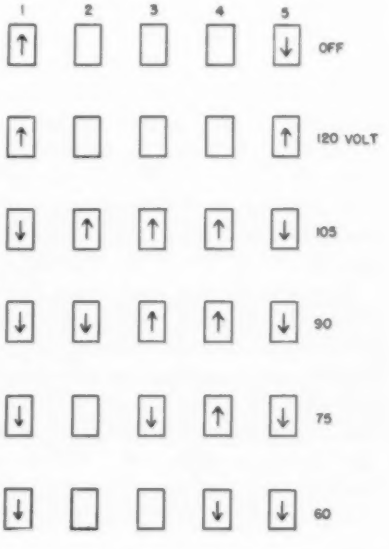


TABLE V — Dimming in Living Room.

V (volt)	I (amp)	P (kilowatt)	η (lumen per watt)	T (°K)	Lamp life (hr)	D_{AV} (footcandles)	
						Calculated	Measured
120	26.0	3.12	12.0	2800	1000	34.6	33.7
105	21.2	2.54	9.37	2650	5680	22.0	21.3
90	16.7	2.01	7.06	2480	43,000	13.1	12.5
75	12.6	1.52	5.04	2300	470,000	7.09	5
60	9.0	1.08	3.34	2090	8,600,000	3.34	2

the number of switches available is distinctly limited. A single switch was not available. Simple snap switches were finally used. A bank of five of these switches is used to give the five levels or turn off the entire ceiling. The circuit diagram is given in Fig. 6. Note that the transformer draws no power except when actually in use. The only disadvantage is that there is a neat bank of five identical switches on the living room wall. The owner must remember the key (Fig. 7) to the switch panel or he will be unable to operate the switches intelligently. However, random throwing of this group of switches can do no real damage. A random variation of the lighting may result with the worst possibility that lights can be turned off while current is still passing through the transformer.

The transformer is installed in the basement. No hum is audible in the living room; a minimum hum is barely audible within a few feet of the transformer.

Once switch and transformer were installed (October 25, 1956), the results were far beyond expectation. The possibility of changes in mood were admirable. All of the levels were delightful, each for its own purpose. Even at the lowest level (Table V), visual conditions were surprisingly good. A luminous ceiling with soft, firelight quality at 2 footcandles has the same excellent adaptation ratios as at high levels; and even without large quantity, these provide remarkably good visual conditions. For easy visual tasks or listening to music, the 75-volt level is delightful with its twilight quality. For casual writing or reading, the middle level is quite satisfactory. However, for study, serious reading, or typing, the 105-volt level with its daylight quality is most often chosen. And for really difficult visual tasks such as drafting, the soft sunlight quality of the highest level is available.

Calculated characteristics of the dimming circuit are given in Table V. When the voltage is cut in half, current and power drop to one-third of their initial value, the number of lumens per watt drops by a factor of four, and quantity of light drops by a factor of 10 or more. The extreme color change is associated with a drop of over 700K in the

Figure 8 (below) and Figure 9 (right). Luminous ceiling installed in kitchen of a modern home, without and with the plastic diffuser.

operating temperature of the lamps. Lamp life is increased to over 8000 times its rated value. Only one of these sets of values has been checked by measurement. The quantity of light received at table level follows the theoretical curve at the three highest levels and then exhibits larger errors as would be expected from the fact that the equations are only supposed to be accurate for small variations in voltage.

Building a Modern House

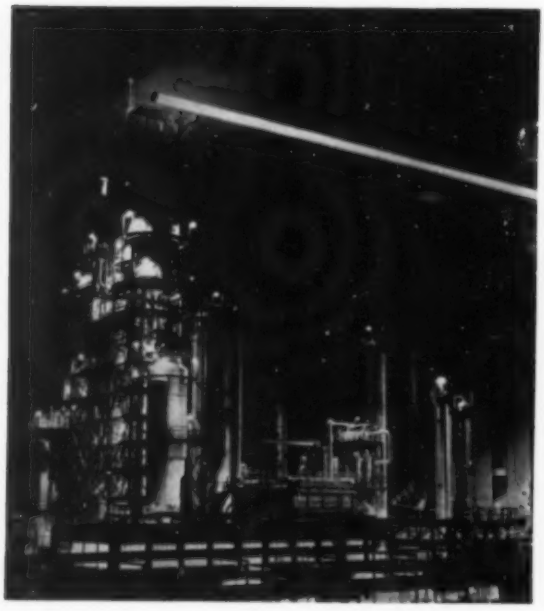
Another example in which a luminous ceiling, with 30-volt incandescent lamps and five-step dimming has been employed is the home of John and Mary Owens in Belmont, Mass. The architect, J. Robert Hamilton, had designed space for a luminous ceiling above the kitchen of this modern home. The advantage of planning for a luminous ceiling from the start is that adequate depth can be provided without aesthetic damage. Here a space 26 inches deep with only one obstructing beam insures an efficiency of over 60 per cent. The deeper spacing also permits a smaller number of lamps to be employed as the lamp spacing can here be increased to between 18 and 21 inches. Such a luminous ceiling is somewhat more efficient than the shallower ones that must be used in most renovated homes.

Figs. 8 and 9 show this modern kitchen both with and without the plastic. The results are again delightful. The aim of a utilitarian and decorative installation has been satisfied.

Conclusions

Luminous ceilings are suitable for lighting both traditional and modern homes. Such ceilings should be designed to be both decorative and utilitarian. They tend to be shallower than the average luminous ceiling and to provide smaller quantities of light. The color is more becoming, more friendly, and correlates better with the rest of the house if incandescent lamps are employed. Though incandescent lamps are inherently less efficient than fluorescent lamps, part of this differential can be recaptured by employing series-parallel arrangements of 30-volt incandescent lamps. Dimming of such lamps in five discrete steps has been shown capable of providing an astonishingly wide range of change of mood, from firelight to sunlight.

Further steps which should be taken are the provision of still more decorative appeal by the use of colored detail in small areas of the luminous ceiling and the extension of the design problem to complete, interesting, decorative and utilitarian luminous ceilings throughout new homes.



Aircraft Beacon Tops Petroleum Processing Unit

Visible from the air as far away as 300 miles, and from the ground as far as 40 miles, the Wilshire Oil Co.'s 500 million candlepower searchlight serves as a visual identity marker for their Los Angeles catalytic cracker petroleum processing unit. Located on top of the 20-story high structure, the beacon makes one complete sweep of the horizon every minute. Weighing more than two tons, the five-foot diameter searchlight is so balanced that it requires only a one-third horsepower electric motor to revolve it. The Civil Aeronautics Authority is said to welcome the installation as an additional navigational aid.

Photo and data courtesy of Federal Sign and Signal Corp., Chicago, Ill.

A cooperative apartment offers its occupants many of the opportunities for "fixing up" that a house does. It is not subject to the usual restrictions which leases for rented apartments contain, nor is there the feeling of "why spend money on someone else's building, we might be moving in three years." When the money is there to be spent, and is spent wisely, owners of cooperatives can make them truly congenial homes, adapting their surroundings to their own preferences and tastes. This was accomplished by these owners in one of Detroit's newest downtown cooperative apartment buildings.

Home Lighting—Cooperative Style

By MARY TAEPKE

AFTER THREE long years, the new 15-story cooperative apartment building was finally completed. While waiting for the day, the owners of the 14th floor apartment had beguiled themselves by compiling a scrapbook of ideas on lighting and decoration. When construction was complete, and all was ready, the lighting specialist and interior designer were called in.

The owners of the apartment have strong personal likes and dislikes in what they want around them, and their three-year period of research and study had, if anything, fortified their convictions. One unusual feature of the lighting design was caused by their opposition to the use of portable lamps. Despite assurances that table lamps and floor lamps can be both useful and decorative, only four table lamps were allowed in the apartment. Building construction (except in the bathrooms) did not allow recessed fixtures, so surface-mounted downlights, valances, cornices, and indirect lighting are the techniques used. Colors and decorative devices were also strongly influenced by the owners' personal tastes.

Layout of the apartment, too, is designed to meet the living patterns of its occupants. In addition to the formal living room, there is a family room for informal entertaining. The master bedroom and guest bedroom each has its own bath. The kitchen is the last word in modernity, and the dining area is adaptable to varying numbers of gourmets.

Based on a paper presented at the Residence Lighting Forum of the National Technical Conference of the Illuminating Engineering Society, September 9-13, 1957, Atlanta, Ga. AUTHOR: The Detroit Edison Co., Detroit, Mich.

Living Room

The formal living room is 37 feet long, 11 feet wide at one end and 16 feet wide at the other. From the main entrance a small foyer leads directly into the room. A monotone of soft warm beige was chosen for the painted walls, the draperies and the carpeting. Muted blue, turquoise and bright coral accents are carried out in upholstery fabrics and accessories.

Carefully designed cornices run the entire 37 feet of window area, frame the end window and light the muralled wallpaper on the inner wall. A painted concrete pillar, part of the building construction, extends 13 inches from the window — a structural element which furnished an architecturally suitable

View of living room showing hallway.

device for locating the cornice faceboard much farther from the window than is usually decoratively acceptable. In addition to the 3¼ to 4 inches necessary for the continuous 40-watt fluorescent channels and lamps, stacking space for draperies and space for the vertical louvered blinds required extending the cornice in about 12 inches.

In lieu of the decorative element normally supplied by portable lamps, large plants are used to achieve the appearance of "sculpture" against the background of luminous curtains.

Supplementary illumination is supplied at the electric organ by a special unit, using two 15-watt lamps, mounted on the music rack.

As a change of pace from the completely downward lighting along the windows, 40-watt fluorescent strip, mounted on top of the storage and coat closets on the inner wall beside the foyer provides indirect lighting. This and the other inner wall lighting is used alone, when often at night the draperies are drawn back for the view of night-time Detroit. Dimmers are used for low levels of illumination, permitting safe passage and identification of people with a minimum of distracting reflections on the windows.

Family Room-Dinette-Kitchen

For informal occasions, such as visits by the owners' three lively grandchildren, the family room is suitable for entertaining. Actually, it, the kitchen and the dinette are one room, separated into the functional divisions by a room divider. In the living section, general lighting is indirect, from 60-watt lumiline lamps on top of the room divider and cabinets. Valance lighting at the opposite window also provides general illumination. A davenport, not shown in photo, is flanked by two end tables, each with a portable lamp for reading. Four feet out from the cabinet wall, an arm chair also requires additional light. Since a normal traffic lane lies directly behind the chair, a floor lamp would be an obstruction. A surface-mounted 150-watt reflector flood lamp in a cylindrical housing, mounted on the ceiling directly above the chair, was the solution, providing 22 footcandles for casual reading tasks.

The desk surface and book case interior are illuminated to 20 footcandles by 60-watt lumiline strips on pencil-slim channels, with 3-inch wide valances to conceal the light sources. Glass panels in the top of the divider allow downlight from the lumiline lamps above.

Lumiline lamps were chosen for this area for two reasons — first for color, to harmonize with the walnut panelling and the room's soft beige and wood tones; and, more practically, to avoid interference in the Hi-Fi equipment which is housed in the room divider.

At the window side of the room is the dinette, where the table is highlighted by either one or two surface-mounted 150-watt louvered cylindrical units individually switched. When the table is extended both fixtures are used; when it is not, one unit is centered over the centerpiece. Dimmer controls provide a "moonlight" level that does not interfere with night-time viewing of the river. Over the windows, a continuous valance concealing four

40-watt rapid-start deluxe white lamps is also on dimmer control.

Wall-to-wall flecked beige cotton carpeting is used in each area of the room, even in the kitchen! The carpeting is washable, and according to the owners is also practical. The kitchen is remarkable in other aspects too. All appliances, cooking units, even the faucets for the stainless steel sink, are hidden from sight, concealed behind track sliding doors. Cabinets are of walnut, and the counter top is marble.

The kitchen side of the room divider houses a roll-out ironer and ironing board complete with connected hand iron, cabinets, and two wall ovens, one electronic. Also in the compact divider is a wall freezer, turquoise in color.

Indirect lighting is from cove treatment of the cabinet tops and room divider top, with 60-watt lumiline lamps. Five surface-mounted, glass louvered pierced metal cylindrical fixtures, with 150-watt lamps, provide downlight over the counter area. An adjustable ceiling fixture directs additional light to the ovens.

Kitchen.

Master Bedroom and Guest Bedroom

Leading off the family room is the master bedroom, where the color scheme is peacock blue and green. Room furnishings reflect the owners' interest in both oriental and modern design, with East Indian headboards for the beds, French Provincial end tables and bureau, and modern chairs, all used together. This varied assortment of styles is framed by softly lighted walls around three sides of the room, with valances over the windows and cornices on inner walls, all lighting on dimmer control. Adjustable counter-balanced bed lamps are individually switch-controlled from wall switches at the rear of the bedside table. One of the few portables in the apartment serves the two comfortable reading chairs.

Wall lighting and drapery lighting are used for general illumination in the guest bedroom also. Here the window valance is again of standard de-

Family room (left) and dinette (right) are used for informal entertaining. These areas and the kitchen are actually one room, separated by the room divider.

Master bedroom.

sign, but the wall cornice is of special construction. A 4½-inch bottom lip, upon which the fluorescent channel and lamps rest, has been added as a shield for the light source. Deluxe warm white rapid-start lamps are used, and the linear lighting of the walls does much to keep the overall pattern of yellow and brown wallpaper and matching draperies from overpowering the room. Adequate levels for reading are provided by a three-light reflector-style table lamp.

Bathrooms

The two bathrooms are similar in both layout and lighting, and each matches its bedroom in color scheme. Recessed infrared and time-switch controlled sun lamps are "extra" features, as is the inter-communication system with every other room, which is located in the master bath. Standard recessed lighting over the mirrors delivers about 45 footcandles on the face.

Guest bedroom.

One of two similar baths.

Fifty Years of Signal Lighting

By F. C. BRECKENRIDGE

In its purpose and methods signal lighting stands apart from illumination as a separate branch of lighting. It is an extensive field with problems as varied as those of illumination. Although most people seldom give it a thought, it affects the lives of all travellers including pedestrians. As a combination of untoward events prevented the inclusion of this subject among those treated in the fiftieth anniversary issue in 1956, it seems desirable to fill that gap with the present review. The great variety of the devices used for signal lighting and their unfamiliarity to illuminating engineers make it desirable to present pictures of most of the equipment mentioned but this is impossible within the space that can be allotted to a single article. For this reason reprints will be made available with the full set of illustrations if sufficient interest is indicated. Those wishing reprints with all the pictures should write to Clayton E. Ellis at I.E.S. Headquarters. Price is $1.00 per copy.

Introduction

The art of signal lighting can be traced back to the use by prehistoric man of camp fires and flaming brands to guide returning fishermen to their tribes. There are historical references to regularly maintained lights on towers that go back 2600 years. The most famous of these early structures, and probably the tallest tower ever built for a signal light, was the Pharos of Alexandria. Built about 250 B.C., this structure towered 400 feet into the air. It outlasted two civilizations, surviving the Roman empire by nine centuries.

The oldest surviving signal lighting structure was also built for the mariner. It is a wave-swept tower on the coast of France built in 1584 and is still in service. Its classical architecture (Fig. 1) contrasts strangely with the functional simplicity of a lighthouse of the present day, such as the Cape Hatteras Light built in 1870 (Fig. 2). Not only was the art of building wave-resistant towers well developed fifty years ago, but so also was the science of computing the optical design of their lenses (Fig. 3). By this time electric lights had been tried for lighthouses but the usual light source for these great lenses was the concentric wick lamp. In addition to the great landfall lights in which these lenses and lamps were used, the lighthouse services of that day maintained their lesser lighthouses, lightships, buoys, and post lanterns performing the same functions as they do today. Some of the post lanterns, it must be admitted, were not as scientifically designed as the great lighthouse optics. Some were merely lanterns on poles.

Signal lights on vessels, although not so highly developed as their counterparts on shore, had long been an established custom. Sailing vessels were still in common use, and everyone has seen pictures showing the red and green navigation lights mounted on the shrouds of a foremast.

On the railroads also signal lighting was already well established fifty years ago. As early as 1857 (Fig. 4), lanterns hung from a cross bar gave the railroads a block signal visible by night as well as day. By 1905 the block signals were mostly semaphores with colored discs transmitting the light of oil lamps at night (Figs. 5 & 6). Similar lanterns were used as switch lights to let the engineers know how the points were set. The trains of this period were carrying kerosene signal lights at their rear (Fig. 7). These performed two purposes. They showed red lights to the rear to warn oncoming engineers that the track ahead was occupied and they showed green lights to the side to assure dispatchers that no cars had been lost off the passing train.

The only ancient signal light known on the highway is the kerosene lantern. Fifty years ago lanterns with red globes hanging over holes or standing on obstructions were the only traffic signals. The same lanterns, often without the redness in the globe, served as a tail light on a vehicle. Specialized lanterns were available for the equipages of the wealthy (Fig. 8).

To give this review a semblance of organization, developments will be discussed by decades starting

AUTHOR: National Bureau of Standards, Photometry and Colorimetry Section, Washington, D. C.

with 1905. The review will be limited to devices used for four types of transportation, that is transport by road, by rail, by water, and by air, mentioned each time in this order.

1905-1915

At the beginning of the first decade the motor car was still a rarity but it was not long before head and tail lights appeared on it. At first these were kerosene lamps but acetylene quickly made them obsolete, only to be replaced by electric units before the end of the decade (Fig. 9). By that time the increasing number of automobiles had brought the realization that traffic regulation was needed on busy streets. The first attempt to do this with lights was made in Cleveland in 1914.

In railroading, the close of the decade saw the introduction of a new principle of signal lighting. Progressive railroads were electrifying their signal lights in locations where electric power was readily available, and this made it possible to use position light signals (Fig. 10).

In marine lighting the period was characterized by the introduction of more efficient light sources. The concentric wick lamp of the great lighthouses was giving way to the incandescent oil vapor units. These took advantage of the relatively high brightness available from a Welsbach mantle. For lights afloat, gaseous illuminants were becoming available. Two methods of using them were being tried. In some, Pintsch gas was compressed into the bodies of buoys. This gas was piped through a pressure regulator to a lantern where it burned in a small mantle at the center of a cylindrical lens. In the other type, a chamber within the buoy was loaded with calcium carbide. Sea water was brought into contact with the carbide and the resulting acetylene gas was fed to little burners (Fig. 11).

During this decade the flying machine became the biplane and the monoplane but both were daytime devices and if the phrase "aviation lighting" had been used, it would have been considered a joke.

1915-1925

During the second decade there was considerable interest in highway traffic signals. The first step was to provide the traffic officer with a light to supplement his arms in controlling traffic. Most of these lights were simple but some were well developed (Fig. 12). It soon became apparent, however, that more regulation was needed than could be provided by officers, and before the end of the decade the sight of automatic lights, silhouetted against the sky, became common in all our larger cities (Fig. 13). Some cities, with streets in which they took especial pride, believed that these demanded more esthetic installations (Fig. 14). Those erected on Fifth Avenue, New York, have probably never been surpassed for appearance and their large signal lights were visible for blocks without excessive glare. Meanwhile, during this same decade, the brakelight won a place among the items of standard equipment on motor vehicles.

Railroad signal lights were improved through the introduction of battery-operated electric lamps for roads which did not use electric power for operating trains. By using higher intensities and surrounding the signal with a black shield, colored lights could be made visible in daylight (Fig. 15). The color and position principle were then combined on some lines in units which provided both methods of distinguishing the signals. The substitution of these "searchlight" signals for the semaphores contributed to new records of regularity and safety since the luminous signals were visible further and were mechanically simpler. The most significant progress, however, was probably the introduction of the first lights into locomotive cabs to provide a signal which could not be reduced in its range by fog (Fig. 16).

The trend toward electrifying signal lights was also evident in the marine field. Progress was slow in this case, however, because at that time lighthouses were seldom near enough to power lines for commercial power and the quantities of power required precluded the use of batteries. Engine generators were tried but were less satisfactory than incandescent oil vapor lamps which could produce light directly from the oil. There was, however, a great improvement in acetylene buoys. Compressed-gas cylinders proved to be much safer than carbide generators and the pressure afforded a supply of energy with which to flash the light (Fig. 17).

In the early years of this decade airplanes were making headlines in the European War. Sometimes they returned to their fields in the twilight and the pilots wanted lights to guide their landings. These were improvised by burning gasoline or kerosene in old tin cans. A line of three or four such flares proved a great help to the slow landing planes of those days and the principle proved important for later developments. By the end of the decade the Air Corps was carrying on regular experiments with landing lights (Fig. 18).

1925-1935

In the third decade there was a great increase in the use of traffic signals on highways, but the trend in their design was from the esthetic to the practi-

cal. Since a tower obstructs traffic, and lights suspended over an intersection are above the vision of motorists, new installations were more frequently made on the corners of an intersection (Fig. 19). The art of traffic signal control was also advanced through the study of timing intervals and the introduction of better means of controlling the lights. The positions of the signal lights with reference to each other were standardized so that color blind observers could interpret them. An exception to this standardization still exists, however, in installations which attempt to serve more than one direction from the same lighting unit and consequently cannot provide the standard arrangement in all directions.

There was also progress in the signal lighting of automobiles. Retro-reflectors were introduced to protect cars from rear end collisions when parking lights were not lit or taillights failed. A few cars were equipped with backing lights and in one case at least a good design was achieved through the use of three separate lighting units so that a double light appeared when both taillight and brakelight were lit. The fact that this design did not come into more common use was probably due to progress taking a different direction. During the latter years of the decade cars began to be equipped with taillights and brakelights on both rear corners for greater safety.

In railroad signaling, the interest during the third decade was largely in the improvement of track circuits to handle heavier traffic and to meet the requirements of automatic train control. There was also substantial progress on coal burning railroads in the replacement of oil lanterns by lights supplied from batteries. Confidence in cab signals increased, and some roads began to depend entirely on them without wayside signals. The growing tendency to depend upon lights during the daytime led to the development of higher intensity signals in which the change in indication was obtained by moving small discs of colored glass into a focal position within the unit (Fig. 20). The increasing growth of traffic, especially the addition of many commutation trains, necessitated some impressive signal installations (Fig. 21).

The interest in electrifying marine lights continued and towards the end of this period a very satisfactory unit for use in buoys and minor lights was developed (Fig. 22).

It was during the decade from 1925 to 1935 that aviation lighting became important. The efforts to fly mail and carry passengers soon showed that if commercial aviation were to save time for either letters or people, the planes would have to fly at night since, with the 100-mile-an-hour top speed available to aircraft at the beginning of this decade, the advantage gained over the train by daytime was lost during the hours of darkness. The experiments already carried out with landing lights made it evident that some additional guidance would be necessary to enable the pilot to find his way from field to field. The solution of this problem seemed to be the establishment of beacons comparable to those used for marine navigation. Two factors, however, led aviation beacons to develop quite differently from the marine beacons in the United States. A great many beacons were needed all at once and the funds were limited. This made it impossible to use the expensive optical systems which had been developed for lighthouses. On the other hand, most aviation beacons could be supplied with electric power and the electric lamp with its small filament and high luminance did not require such a large optic as the oil lamp. This led to an effort to solve the problem by using four Ford headlamps rotated by an electric motor, but this proved inadequate to the needs of the pilots (Fig. 23). Later tests led to the 24-inch beacon (Fig. 24).

With the Air Commerce Act of 1926 providing for the establishment of lighted aids for air navigation, the construction of lighted airways began. A typical installation provided an airway beacon standing on a concrete arrow to show the direction of the airway by day and equipped with course lights to provide additional guidance by night (Fig. 25). The location was identified by the site number painted on the roof of the generator house.

In the early days of aviation lighting, there was a realization that low visibility would be a serious handicap to the safe navigation of airplanes, and there was a natural desire to circumvent this handicap by finding a light source that would penetrate fog. Some pilot would observe an unusual light, get the impression that it was penetrating the clouds better than common lights, and give his views to the press. Most of these rumors evaporated quickly but those attributing fog-penetrating powers to neon lamps were persistent. Finally, in 1928 a test was made that showed the light from neon lamps to be attenuated in fog like any other visible radiation. Neon lamps have since been used only when their color and shape made them especially suited to the requirements.

As flying from field to field after dark became common, pilots soon found that the landing lights on the airplanes did not give them all the lights they required for landing. The parachute flares which had been developed for military use gave an excellent light for an emergency landing, but because of their cost they could not be used for the scheduled stops. This led to a great deal of experi-

mentation with floodlights culminating in the historic series by the Air Corps in 1927 (Fig. 26). A field illuminated with one of the larger floodlights of this period was a spectacular sight (Fig. 27).

Notwithstanding the floodlighting, pilots wanted to know the exact limits of the landing areas which were regarded at that time as "allway" fields. The first lights used for this purpose consisted of electric lamps covered with simple domes of glass, but these soon gave way to lights designed to concentrate the light at the most useful angles (Fig. 28). With red glass globes the same lighting units could be used to mark an obstruction. Such marking was soon found to be an essential part of aviation lighting. A later form of this light was mounted on a cone painted to serve as a day marking device (Fig. 29).

For a safe landing, the flyer also needed to know the direction and strength of the wind. This led to the establishment of wind cones which had to be lighted to make them visible at night (Fig. 30). The meteorologist, on the other hand, was confronted with the problem of determining the ceiling height at night. This problem was solved with the development of narrow beam ceiling lights which provided relatively small spots of light on clouds to enable the weather man to determine their height by triangulation.

As aviation grew throughout the decade, the need for identifying airports arose. This was solved by the introduction of the code beacon (Fig. 31). An effort to provide better beacons for airports led to a four-beam 24-inch beacon with a little spotlight on top directed straight up (Fig. 32). This spotlight suggested that the aviation lighting engineer of this period was too often like the "ruler of the queen's navee" in *Pinafore* who attained his eminence by "never going to sea at all." Those engineers who participated in flight tests realized that the pilot could never see down at an angle greater than 45 degrees and consequently light emitted at higher angles could never be utilized. The increasing traffic at airports also required regulation. The first practical air traffic control projector was developed in 1932 (Fig. 33).

Another requirement which was discovered early was a need for lights to mark the airplane itself to enable pilots to avoid collisions. In this case again, aviation practice followed what had been developed for marine use, although the means of providing the light had to be entirely different in order to meet the weight and drag limitations of an airplane. The first position lights consisted of electric lamps with cellulose plastic covers stained with organic dyes to transmit red and green light and painted black at the angles where no light was desired. These were most unsatisfactory since the black tended to fade and the organic dyes both darkened and lost color so that after a short period of use there might be more light coming out where none was intended than through the part which was supposed to give the signal. Moreover these early lights did not take into consideration the need for higher candlepowers in a forward direction. Before the end of the period, position lights were in production which utilized glass covers to provide a dependable color, metal shields to give a definite cut-off angle, and reflectors to redistribute the light into the sectors where it was most needed.

As the pilots' experience increased, they realized more and more that floodlights in their eyes were little else than a nuisance, and this led increasingly to the demand that floodlighting be adapted to the wind direction. One answer to this was the mobile floodlight (Fig. 34). Meanwhile the lighting engineers were looking ahead to the need for furnishing the pilots with more precise guidance than any obtainable from floodlighting. The ever-increasing traffic and the use of heavier planes was making the allway field obsolete. The runway was becoming a necessity. An effort was made to mark these by installing lights along their edges, but here again the initial installations overlooked the uselessness of light emitted vertically. The poor results obtained from these early installations led to a search for methods of making runway lights visible to the pilots. The cover glass was crowned to scatter a low intensity in the direction of the pilot and a vertical rubber flap brightly lighted by the beam from below was added (Fig. 35). No real solution to this problem was in sight, however, until it was demonstrated by the Air Corps that it was not necessary for runway lights to be fully flush (Fig. 36).

1935-1945

This period saw no startling developments in the design of highway traffic lights, but in other respects the traffic signal engineers were making progress. A standard sequence of colors, namely green, yellow, and red with return to green, was pretty generally adopted. The timing of the lights was improved through the use of synchronous motors operating on the general power service. This kept the traffic signals over large areas in proper relation to each other.

In the field of railway signaling, interest continued to center around automatic controls and the requirements of heavier traffic. This resulted in highly complicated railway signal circuits with cab and control tower indicators. Although these cir-

cuit problems required most of the attention of the signal engineers, progress was made in the design of lighting units (Fig. 37).

For the electrification of lighthouses requiring high intensity beams, a unit composed of two 36-inch aviation beacons was developed (Fig. 38). The combination has been so designed that the angle between these two units can be varied to change the characteristic of the light. The optical system has ben modified to increase the duration of flashes, and the gearing in the base has been arranged to permit a range of speeds. Even with these modifications this type of unit was considerably less expensive than the elaborate units built with polished glass prisms which had been standard lighthouse practice in earlier decades.

All forms of aviation lighting progressed during the decade from 1935 to 1945. Improved aircraft position lights of lighter weight and better candlepower distribution were developed (Fig. 39a). The higher speeds of aircraft made it impossible to tolerate the drag of a landing light slung below the wing. At first an effort was made to build lights into the wing, but such lights proved impracticable because the wing had different contours. Retractable lights in two sizes solved the problem (Fig. 39b). From the start, the matter of lighting the instruments so that the pilot could read them at night had been a problem and little spotlights were developed as an answer (Fig. 40).

The problem of giving the pilot proper weather information also received study. The wind cone gave a good indication of wind direction from some positions but from other positions it was more an indication of wind velocity. At intermediate angles the indication could not be deciphered. To give a more definite indication of wind direction the wind-T was developed (Fig. 41). This had the disadvantage of being difficult to read from the ground and the wind tetrahedron was designed to solve this problem (Fig. 42).

This period also witnessed the completion of the transition from the allway concept of aircraft landing to that of channelized traffic. There was considerable activity in the development of runway lights illustrated, for example, in the sodium lamp units (Fig. 43). The final development of semiflush runway lights used an incandescent lamp with an annular lens rising about two inches above the runway pavement. A flat steel plate covered the center and protected the glass (Fig. 44). As runway lighting improved it became obvious that floodlighting any other part of the field was useless and field floodlighting gave way to runway floodlighting (Fig. 45). Projectors for ground traffic control were installed on some runways and taxiways and traffic control desks with signal lights in most airport control towers (Fig. 46).

During this decade beacons continued to be an item of considerable interest in aviation and two improved types were brought out. Their mechanisms were more accessible and dependable and obscured less of the reflector surface. In one of these designs the moving parts were entirely under cover. This reduced the danger of their "freezing" in cold locations (Fig. 47). A smaller type of totally enclosed beacon was designed as part of a program to meet the need for low-cost lighting equipment for small airports (Fig. 48). At large airports quite a different set of problems confronted the lighting engineers. One of these was the elimination of the phantom lights which were a constant source of irritation to the airport traffic controller. By an ingenious tilting of the windows the phantoms were reflected upward and downward leaving the signal lights without competition (Fig. 49).

During this decade two lighting devices were developed to assist airway meteorologists. One of these was the daylight ceiling-height indicator which solved the problem of distinguishing a patch of artificial light on the bright surface of a cloud by using a modulated light beam and a tuned receiver which could distinguish the modulated light from the general illumination. The other device was the transmissometer for determining the transmissivity of the atmosphere. The transmissometer has the advantage that it can be located in the area which is of most importance to the pilot and thus enables the control tower operator to inform the pilot as to conditions in this area instead of misleading him with observations based on weather at some other location a mile or two away (Fig. 50).

It was early in this period that the approach-light problem had its birth. Efforts to land in low visibility made it evident that some sort of visual guidance was desirable to enable a pilot to make contact with the ground before the runway lights could be visible to him. Approach lights were developed for this purpose. Later when the radio aids to landing reached a practical development, it was found that a connecting link between the radio guidance and the runway lights was still needed. At the time the first neon approach lights were being developed, all lighted aids were considered to be useful at night only and the candlepower of the neon lights was higher than was being used for other lights that seemed comparable. After they were in use, it was proposed to use lights in the daytime as well as at night. To prove the feasibility of this and determine how much increase in intensity was required, tests were carried on in

the fogs of Nantucket during two summers and during the low visibility periods of three Indianapolis winters (Fig. 51).

The Nantucket-Indianapolis tests proved that it is feasible to use approach lights in daytime fog provided sufficiently high intensities are used. It was also found that the pilots who participated in the tests all preferred a two-line system to a single row on the left side of the approachway. The two-line idea was adopted for wartime installations (Fig. 51). Unfortunately these wartime lights were far below the intensity which had been found desirable in the Nantucket tests. Moreover, these wartime units had very narrow beams. This gave these systems a very serious weakness, for frequently only one row of lights would be visible to the pilot who could not tell which row he was seeing. In spite of this they no doubt saved many pilots from crashing.

Attempts to give the seaplane pilot the advantages of channel lighting led to the development of seadrome lights. Most of these were very lightweight buoys carrying fluorescent lamps (Fig. 53), but experiments were made with lights mounted on piles (Fig. 54).

Towards the close of the decade it was found that runway lights could be mounted above ground if frangible mounts were used. This made it possible to obtain enough light along the runway to meet the needs of daytime fogs. At least five different types of above-surface units were available for runway lighting at the close of the decade (Fig. 55). The installation of these lights was facilitated by a rubber encased transformer which was originally developed for military use. It proved to be of great value in increasing the reliability and reducing the maintenance costs on civil airways as well.

1945-1955

Traffic signals have continued to increase in number and complexity. Now, over 700,000,000 times a day some driver receives a signal. To the simple go-warning-stop sequence there has been added left-turn, right-turn, and "thru" arrows, and combinations adapted to five or more streets intersecting at the same point. Special lights have also been developed for the control of pedestrian movements (Fig. 56), and a system of stopping all vehicular traffic for a brief interval while pedestrians cross an intersection in all directions has been introduced. This all-way system has been growing in popularity for busy intersections.

The rear lighting of cars has been improved in three respects. Turn-signal lights have been introduced, backing lights have been made standard equipment, and the intensity of taillights and brakelights has been increased (Fig. 57). This last change, although needed for higher speeds and daylight fogs, has made the brakelight signal even less dependable. The varying effects of distance, atmospheric transmission, background brightness, and lamp design make the use of intensity as a distinction between two different signals inherently unreliable, and the more the intensities and sizes vary, the more unreliable the distinction. Perhaps the next decade will see the standardization of two different configurations to distinguish a car that is stopping from other cars. The situation is presently complicated by the requirement that trucks carry additional lights and these sometimes make a confusing array.

As in the case of the previous decade the improvements in railroad signaling have not resulted in many major changes in the design of lighting units. The use of cab signals seems to be on the increase and the number of indications has increased so that systems giving four and five indications are now in use.

The most interesting developments in connection with aids to marine navigation are concerned with the use of radar and other electronic systems developed as aids to navigation during the war. The use of radar has led to placing large radar reflectors on top of some of the buoys (Fig. 58). Electric buoys are now being operated with special lead-acid storage batteries with low self discharge and nonspilling vents.

Aviation lighting has continued to develop notwithstanding the increasing interest in electronic aids to air navigation. The increasing density of traffic has called for better safeguards to prevent aircraft from colliding, and the warning light, or all-around position light, is one of the answers (Fig. 59). In some of these, a parabolic reflector focuses a beam vertically and this beam is then split by a double mirror into two rotating horizontal beams. It is interesting that this same principle was used in the early days in Europe in the design of an airway beacon. The helicopter has posed new problems in aircraft marking. An interesting attempt to solve some of these problems is the installation of lights on the blade tips. When the blades are rotating these appear from a distance as an ellipse.

The helicopter is also requiring new developments in ground lighting. The most promising of the experiments now being made are those with approach-angle lights which indicate by the color of the beam whether the approach path is too high, too low, or normal.

The still increasing density of traffic has called

for better lighting for taxiways and at least two new units have been developed (Fig. 60). With airplanes landing on runways at a rate of more than one per minute, it is important that each one be able to clear the runway and proceed to its destination as quickly as possible, so that it may not be risking collision with the following airplane. This has led to the development of a system of taxiway guidance signs (Fig. 61).

A novel application for lighting is an illuminated suit for a landing signal officer, the officer who is responsible for controlling the landing of aircraft on carriers. By means of the little lights shown on the paddles and strips on the uniform, the incoming pilot is able to receive the instructions of this officer and so correct his approach to land safely (Fig. 62). Another method of guiding pilots to a safe landing on a carrier deck involves the British landing mirror. This provides a virtual image of a light so placed that the correct path is indicated when this image is seen in line with, and midway between, two outer rows of lights.

There has been continued interest in the development of runway lights. Special attention has been given to keeping the weight low, so as to keep to a minimum any damage done to an aircraft which may strike one of these new above surface units (Fig. 63).

A runway as a pilot sees it on a clear night appears as two lines of lights. At first these lines are nearly parallel and he aligns his flight with them. As he approaches, the near ends of the lines swing outward and at landing appear as two segments that are almost in line (Fig. 64). As long as the pilot heads toward the gap between the lines the plane will not run off the runway. In a fog, however, the lights which define the gap are all lost in the fog. Under such conditions the pilot must judge from the changing directions and apparent intensities of the two or three lights visible on each side whether he is heading toward or away from the center line. One way of mitigating this difficulty is to dissipate the fog. Fido was developed for this purpose (Fig. 65).

Fido was of considerable help to pilots in Alaska and England during the war; it has not yet proved practicable for commercial use. This still leaves the problem of finding the most effective configuration and candlepower distribution for lights to be used to guide landing aircraft to and along runways during periods of bad visibility. It was the primary purpose of the Arcata program to find the answer to this problem.

During the course of the four seasons that the Landing Aids Experiment Station was continued in operation, tests were made on six systems. These included: two converging rows with the largest approach-light units ever tested (Fig. 66); multiple parallel rows with units which could be directed by remote control; the slopeline system which indicated the height as well as the location of the approachway (Fig. 67); the Calvert system which emphasized the distinction between lateral error and banking by a center row with six transverse bars, a left-row system with fixed and sequence flashing lights; and a center-row of short bars (Fig. 68). Not all of these were installed at one time since many units had to be installed on towers to make the configurations level. Enough were installed by the end of the period to give the area the appearance of a steel forest (Fig. 69). The slope line system was preferred by the test pilots but among airline pilots only those who used the Arcata system regularly preferred it. The European pilots seem to prefer the Calvert system. The American Air Line Pilot's Association has recommended the center-row system with sequence flashing lights and that is the present civil standard in the United States.

Since the Arcata project was organized to find the optimum configurations for runway and approachway lighting it may be asked why we still do not have the answer. The failure to get the answer at Arcata can be traced to two causes. On the one hand, policy considerations rather than technical considerations determined the program so that individual systems rather than principles were tested. For this reason the results could not be applied to the evaluation of configurations in general. On the other hand, the task is too great to be done by flight testing alone, because of the very large number of variables involved and the impossibility of reproducing any given conditions when the testing on the approachway is being carried on with natural fog.

To meet the conditions which handicapped the testing at Arcata, a device called the Kinorama has now been developed. This device makes it possible for a pilot to see an approach-light configuration speeding by him just as he would see it in flying over it in fog. The course followed in such a simulated flight is determined by the pilot himself who acts in response to the lights that are visible to him. By recording the paths thus followed it is possible to obtain objective records reflecting the merits of the configuration. While the device is not a complete substitute for flight testing for the final approval of a system, it is relatively inexpensive, objective, free from hazards, and not dependent upon the occurrence of fog.

Baltimore Harbor Tunnel

By GARDNER M. SIMES

Basic objectives in lighting tunnels are adequate and comfortable visibility, satisfactory eye adaptation for motorists at portals, dependability of the lighting system, reasonable initial and upkeep costs, and ease and safety of maintenance with minimum interference in traffic flow.

The Baltimore Harbor Tunnel aims at these objectives with a fluorescent system — continuous rows of 12-foot fixtures mounted on the ceiling near both side walls. Each fixture contains the transformer that operates two 6-foot T8 slimline lamps, 12 feet 6 inches on center. One end of the fixture contains the high-tension contact for one lamp carrier, and the other end contains the grounded spring contact for the other end of the adjacent lamp carrier. Lamp carriers are 2-inch diameter Pyrex pipe, 12 feet long, with sealed ends to permit lamps, contact springs, insulators and contacts to be enclosed in a single member.

The continuous row of light source is interrupted only for one foot every 12 feet 6 inches, providing even reflectances from the off-white tile walls and ceiling.

This lighting system is operated on series circuits, incorporating saturable core reactors arranged to vary the current through the lamps from 100 to 450 ma. In this way the level of illumination can be adjusted throughout the tunnel, and particularly at the portals where sharp contrast with daylight can be mitigated. High levels are maintained at portals on bright days, medium levels on dark days and low levels during the night.

Since vehicular tunnels are built to last for approximately 100 years, all components in the fixtures are of copper base alloys — generally accepted as the best for withstanding rough usage and corrosion. Spare carriers with lamps and fittings are made up in the maintenance shop for replacement as units. Changing of lamps, therefore, can be accomplished by stopping the maintenance truck for less than a minute per fixture. Fixtures are virtually impervious to any ill effects from tunnel washing equipment. The only gaskets in the assembly are two 2½-inch diameter neoprene ring gaskets which seal the ends of the carriers.

Author: The Simes Co., College Point, N. Y. Tunnel engineered by the Greiner Co., Baltimore, Md., with Singstad and Baillie, New York, N. Y., as special consultants. Electrical contractor: Nager Electric Co., Brooklyn, N. Y., and Keystone Engineering Corp., Philadelphia, Pa.

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The Patapsco Tunnel Project, owned and operated by the Maryland State Roads Commission, consists of a 6300-foot long twin-tube tunnel and approximately 17 miles of four-lane controlled-access approach roads. The $130,000,000 project provides a bypass around the congested downtown area of Baltimore for all traffic arteries leading north, south and west of the city. Interchanges provide access to highways to and from the city.

and its Approaches

By ERNEST F. SIEGEL

CONSIDERABLE study was given to the selection of luminaires and standards for lighting the 17 miles of approach highways in the Patapsco Tunnel Project. Final choice was for specially-designed four-lamp fluorescent luminaires and davit-type poles.

Design factors of the luminaires provide:

(1) Adjustable mounting, both vertically and in rotation about the central axis,

(2) An effective seal against moisture and insects by a polyurethane gasket,

(3) Provision for re-lamping with very little effort,

(4) Strength to withstand winds of up to 110 miles per hour,

(5) Mounting on davit-type poles without visible hardware.

The standards were chosen with equal care. From the outset, a clean tapered davit-type pole appeared desirable, to keep the lighting installation in line with the modern appearance of the roadway. The standards selected are tapered steel tubes with a curved section of 12-foot radius and a mounting tenon attached tangentially at the end of this section. Luminaires are mounted at an angle of 25 degrees with the horizontal, to assure maximum efficiency in light distribution. Mounting height of the luminaires is 30 feet.

Illumination levels on the roadway average 0.6 footcandle, as recommended for controlled access highways in the American Standard Practice for Street and Highway Lighting.

Power supply for the lighting installation is drawn from the two ventilation buildings, at either end of the tunnel. This permits primary metering and operation at low power rates, since a large supply of power is required for the operation of the ventilation equipment. In addition, it permits control of the lighting installation for the entire project from two points.

Power is distributed from the buildings at 4160 volts, using No. 4 direct buried cable in trenches paralleling the roadways. Where cables cross the road, or where they are installed in structures, they are encased in asbestos cement conduits. On all 53 structures on the project, the operational as

AUTHOR: Green Associates, Inc., Baltimore, Md., designers of the lighting installation. General consultants, the J. E. Greiner Co., Baltimore, Md. This approach road installation won first prize for Mr. Siegel — for the design of the standard — in the Maryland Section's 1958 contest for My Most Interesting Lighting Job.

Route-and-direction sign, floodlighted from below.

well as spare conduits are carried in the parapet walls with pull and connection boxes installed in the parapets.

Transformers, in vaults located on slopes at the side of the highway and spaced approximately one mile apart, reduce the voltage from 4160 volts, three-phase, to 480 volts, three-phase. The transformer vaults are equipped with cut-out switches and fused branch circuit cutouts to permit isolation of any one of the secondary circuits. No. 6 direct buried cable distributes 480-volt power to the lighting standards.

Each lighting standard is equipped with two ballasts, mounted in the luminaire on separate circuits to assure continuity of lighting even if one circuit should fail. This also permits operation at 50 per cent of capacity during periods when traffic count is low. Manual circuit breakers, located in each of the ventilation buildings, permit operators to switch off two lamps in each luminaire over the entire project.

Continuous lighting is installed on all roadways in urban areas where background light from homes or illuminated signs might affect the motorist. Where the roadways pass through rural areas, the lighting is limited to ramps and roadway sections in the immediate vicinity of interchanges. Spacing of poles is graduated between rural and urban areas as a transition to guide the motorist in or out of the more highly illuminated sections.

Underpasses are lighted with single-lamp subway-type luminaires, mounted on the walls of piers, and are fed from alternate circuits. Direction-signs, with route numbers, are lighted from below by fluorescent floodlighting units.

Lighting is automatically turned on, by a time-switch controlled by astronomic time clocks. Control circuits are arranged for future installation of photoelectric controls.

A total of 845 standards and luminaires is used. These are fed from 590,000 feet of high-voltage cable and 895,000 feet of low-voltage cable. A continuous ground network of 175,000 feet of bare No. 6 copper wire, ground rods and accessories connects all electrical equipment.

Know Your Lighting Industry . . .

Progressive engineers, and representatives in any field, keep abreast of developments past and present in their industry, because they know that very often the answers to future events and problems lie in the past. This is as true of the lighting industry as any other, and most I.E.S. members have found a wealth of valuable, usable information in the Golden Anniversary Issue of ILLUMINATING ENGINEERING published in January 1956.

This special 244-page issue of I.E. covered significant developments in illuminating engineering during the preceding 50 years, with photographs, charts, drawings and interesting well-written text. In fact, the Golden Anniversary Issue received an award for "outstanding original research" in a national competition among 653 of the leading trade and industrial publications during 1956.

Many members have joined I.E.S. since January 1956 and may not have seen or even be aware of this very special issue of their official publication, ILLUMINATING ENGINEERING, They, like older members, will find in the issue a vast store of important background information upon which they can draw as they progress up the ladder of development in their chosen field.

A limited supply of copies of the January 1956 Golden Anniversary Issue of ILLUMINATING ENGINEERING is available at 60¢ each, and may be obtained by writing a note or postcard to the Publications Office, I.E.S., 1860 Broadway, New York 23, N. Y.

Studies on

Daylight Availability

By R. A. BOYD

To utilize solar energy advantageously for the lighting and heating of buildings, additional data are required on the availability of daylight and solar heat for variously oriented surfaces, and for numerous geographical locations. This study presents data on daylight availability at Ann Arbor, Mich., for the period March 1953 to March 1954, and correlates these data with theoretical considerations and climatological data as recorded by the U. S. Weather Bureau.

Introduction

Only meager data are available on the variability of exterior daylight intensities. References on this subject are widely scattered[1,2,3,5,6] and only a few of these[3,5,6] are available as illumination literature. To afford additional data in this direction, a study was undertaken on the availability of daylight at Ann Arbor, Mich., for a period to include all seasons. These findings were then correlated with theoretical considerations and climatological data as recorded by the U. S. Weather Bureau. Measurements recorded are for the period March 1953 to March 1954.

Recording Equipment

All measurements were made with a group of five photocells (Fig. 1) mounted on the roof of the Daylighting Laboratory, The University of Michigan, so that an unobstructed view of the sky could be obtained, the cells facing north, south, east, west, and toward the zenith. The supporting shield, painted flat black, reduced the light reflected from the "ground" to a minimum of approximately four per cent.

The photoelectric cells were model 856, as supplied by the Weston Electrical Instrument Corp.[4] Each cell was equipped with a Viscor filter to provide it with the same spectral sensitivity as the human eye, and was placed in a watertight case. A metallic film filter and depolished flashed opal disc were sealed in place over the face of each cell.

A multipoint Speedomax Recorder, with appropriate shunts, was used for the recording. Each of the five circuits was provided with five shunts so that the recorder response could be varied as the photocell response varied. The values of the shunts and the density of the metallic film filter for each cell were selected so that the recorder response was directly proportioned to the illumination incident on the cell.

The photocell case and the opal disc were so designed that the unit obeyed the cosine law of illumination. The maximum error of this corrected unit for undirectional illumination is four per cent, and that occurs for an angle of incidence of 80 degrees. For measuring the illumination due to a uniform hemispherical source, such as a sky having a uniform brightness, this photocell has an error of less than one per cent.

The photocells were initially calibrated and periodically checked with 1000- and 5000-watt incandescent lamps of known candlepower. For the higher levels, corresponding to direct sunlight conditions, the photocells and metallic film filters were calibrated separately and then combined to avoid errors due to lack of application of the inverse square law.

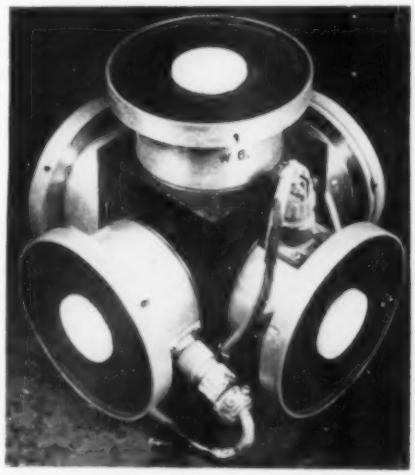

Figure 1. Photocell arrangement.

AUTHOR: Engineering Research Institute, University of Michigan, Ann Arbor, Mich.

Data Recorded

Data were collected with weatherproof cells during most of the working days from March 1, 1953 to March 1, 1954, regardless of exterior weather conditions. The number of days in each month for which data are available are:

Month	Number of Days
March 1953	18
April 1953	20
May 1953	19
June 1953	22
July 1953	22
August 1953	20
September 1953	19
October 1953	17
November 1953	20
December 1953	21
January 1954	19
February 1954	21
	238

Tabulation of Data

Since the recorder provided approximately one intensity reading per photocell each minute, more data were collected on the recorder charts than could reasonably be analyzed for this study. Consequently, it was decided that footcandle readings for each photocell would be selected on a 15-minute-interval basis, from 8 a.m. to 5 p.m. each day. Such a tabulation gave the daylight illumination in footcandles, every 15 minutes, on north, south, east, and west vertical surfaces, and on a horizontal surface.

One aim of this study was to correlate the recorded intensities with the degree of cloudiness and percentage of possible sunshine as specified by the U. S. Weather Bureau. The nearest weather station to Ann Arbor is at Willow Run, which records the degree of cloudiness but not the percentage of possible sunshine. The Weather Bureau indicates the degree of cloudiness as tenths of the entire sky, 0 to 3 tenths being clear, 4 to 7 tenths partly cloudy, and 8 to 10 tenths cloudy. These data were obtained for the entire year from the Weather Bureau Station at Willow Run.

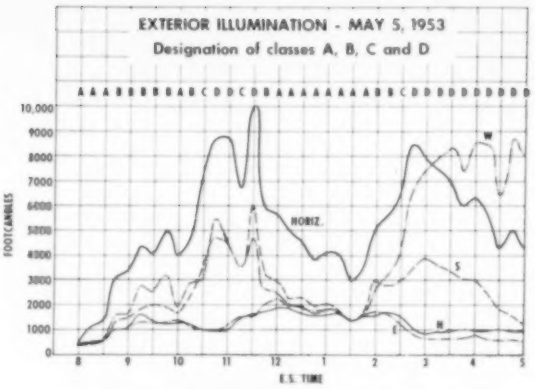

Figure 2. Exterior illumination — May 5, 1953. Designation of Classes A, B, C and D.

An overcast sky is one for which the cloud formation is so dense that all vertical surfaces are equally illuminated. As the cloud density decreases, the sky brightness becomes non-uniform, and consequently the variation in vertical surface illumination with orientation of the surface becomes greater.

In an attempt to obtain some correlation between the measured intensities and the degree of cloudiness, the readings were classified on the basis of the ratio of maximum to minimum vertical surface illumination The classes are as follows:

Class	Ratio Max/Min
A	1.0 to 1.5
B	1.5 to 2.5
C	2.5 to 3.5
D	> 3.5

May 5, 1953, was one of the days during which all four of these conditions existed. Fig. 2 shows the variation of the illumination on the four verti-

TABLE I — Record of Cloudiness
8:00 a.m. to 5:00 p.m. — March 1953 through February 1954

Month	Per Cent of All Days			Per Cent of Measured Days			Sky Cover		Per Cent of Readings			
	Cloudy	Partly Cloudy	Clear	Cloudy	Partly Cloudy	Clear	All Days	Measured Days	Class A	Class B	Class C	Class D
March	84	10	6	88	6	6	8.6	8.7	47	16	9	28
April	74	13	13	70	10	20	7.6	7.2	34	13	5	48
May	58	29	13	68	26	6	7.2	7.9	40	17	7	36
June	40	43	17	41	36	23	6.2	5.9	17	13	10	60
July	29	42	29	32	41	27	5.5	5.5	20	13	10	57
August	23	26	51	20	20	60	4.2	3.8	7	7	5	81
Sept	20	37	43	16	42	42	4.3	4.2	10	10	4	76
Oct	23	23	54	24	12	64	4.0	3.8	17	4	2	77
Nov	53	17	30	55	15	30	6.3	6.3	37	11	6	46
Dec	64	23	13	52	29	19	7.5	6.8	37	10	8	45
Jan	74	16	10	84	5	11	8.2	8.7	70	6	4	20
Feb	61	14	25	57	19	24	7.1	7.0	50	8	2	40
Avg	50	25	25	50	22	28	6.4	6.3	32	11	6	51

cal surfaces and on the horizontal surface, with the readings marked according to the above classification. The readings were plotted as recorded; no attempt was made to account for light reflected to the vertical surfaces from a particular foreground.

Every reading, for the entire year, on the 15-minute-interval basis, was classified in this manner. Table I shows a comparison, for each month, of the following:

1. Percentage of all days, designated as cloudy, partly cloudy, and clear.
2. Percentage of all days for which recordings

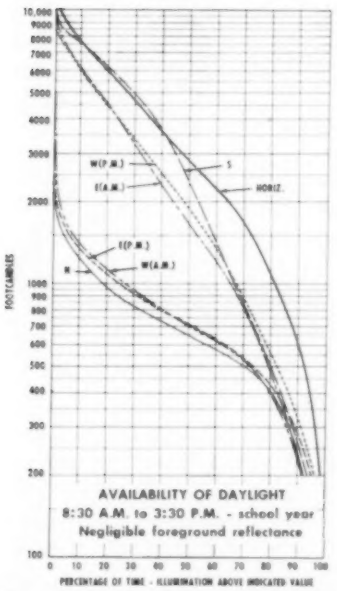

Figure 3. Availability of daylight. 8:30 a.m. to 3:30 p.m.—school year. Negligible foreground reflectance.

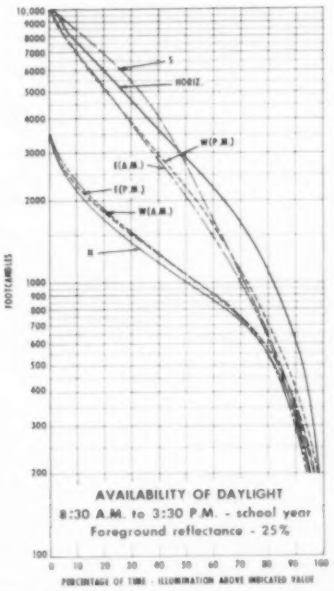

Figure 4. Availability of daylight. 8:30 a.m. to 3:30 p.m.—school year. Foreground reflectance—25 per cent.

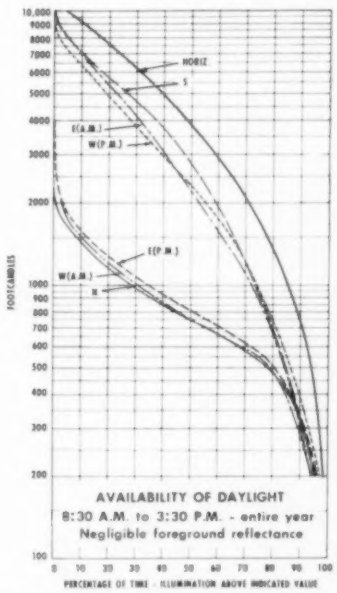

Figure 5. Availability of daylight. 8:30 a.m. to 3:30 p.m.—entire year. Negligible foreground reflectance.

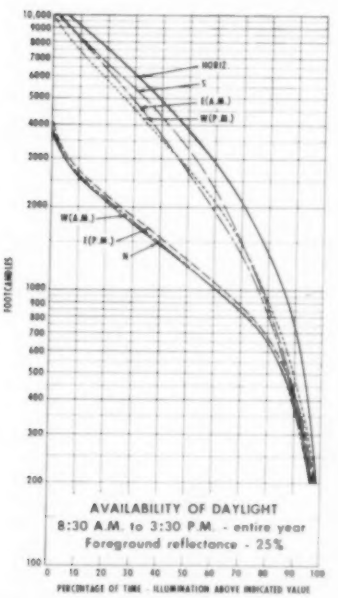

Figure 6. Availability of daylight. 8:30 a.m. to 3:30 p.m.—entire year. Foreground reflectance—25 per cent.

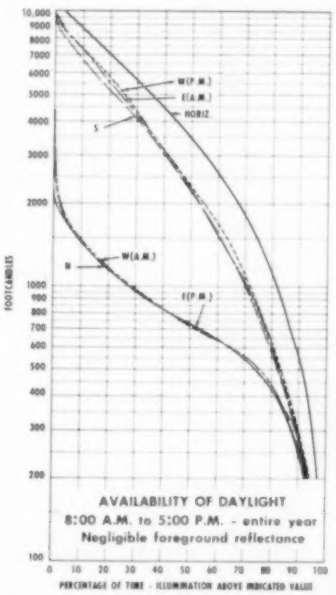

Figure 7. Availability of daylight. 8:00 a.m. to 5:00 p.m.—entire year. Negligible foreground reflectance.

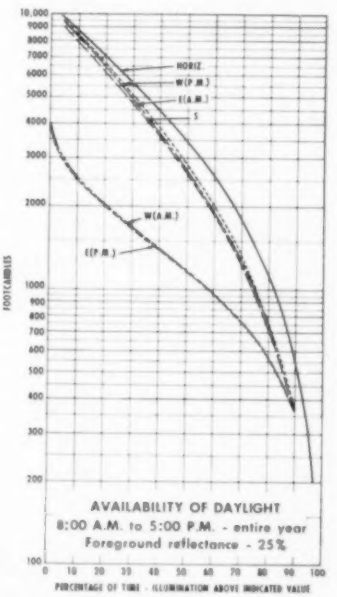

Figure 8. Availability of daylight. 8:00 a.m. to 5:00 p.m.—entire year. Foreground reflectance—25 per cent.

TABLE II — Average Illumination in Footcandles
Classes A, B, C, and D — 8:30 a.m. to 3:30 p.m.

	Class	Number of ¼ hr	Per Cent of Time	Horizontal	Foreground Reflectance — Neg North	South	East	West	Foreground Reflectance — 25% North	South	East	West
Jan 1954	A	374	68	720	340	380	250	370	430	470	440	460
	B	37	7	1560	570	1190	720	900	770	1390	920	1100
	C	23	4	2750	730	1960	1190	940	1070	2300	1530	1280
	D	112	21	2740	730	4810	2000	1400	1070	5150	2340	1740
	Average Classes A, B, C			900	380	530	420	440	490	640	540	560
	Average Classes A, B, C, D			1300	450	1430	755	645	610	1590	920	810
Feb 1954	A	284	50	1140	550	610	550	590	690	750	690	730
	B	44	8	2600	860	1970	1330	1170	1180	2300	1650	1490
	C	12	2	2340	790	2230	1510	1160	1080	1520	1800	1450
	D	229	40	3370	580	5260	2340	1490	1000	5680	2760	1910
	Average Classes A, B, C			1390	600	830	690	670	770	1000	860	840
	Average Classes A, B, C, D			2180	590	2600	1350	1000	860	2870	1620	1270
March 1953	A	223	50	2200	890	1000	930	940	1170	1280	1200	1210
	B	15	3	3020	1040	1700	1320	1420	1420	2080	1700	1800
	C	52	12	4080	1110	3250	1940	1850	1620	3760	2450	2360
	D	158	35	5720	840	5330	3730	2010	1550	6040	4440	2720
	Average Classes A, B, C			2580	930	1450	1140	1130	1260	1770	1460	1450
	Average Classes A, B, C, D			3680	900	2810	2050	1440	1360	3270	2510	1900
April 1953	A	196	33	2590	990	1110	1030	1100	1310	1430	1350	1420
	B	91	16	4110	1230	2220	1670	1720	1740	2730	2180	2230
	C	28	5	5330	1240	3070	2220	2020	1910	3740	2890	2690
	D	272	46	6790	910	4520	3060	2830	1760	5370	3910	3680
	Average Classes A, B, C			3310	1080	1610	1330	1370	1490	2020	1740	1780
	Average Classes A, B, C, D			4910	1000	2950	2130	2040	1610	3660	2740	2650
May 1953	A	230	41	2740	1050	1170	1130	1150	1390	1510	1470	1490
	B	81	15	4270	1500	2160	1730	1740	2030	2690	2260	2270
	C	42	7	5500	1510	3060	2070	2430	2200	3750	2760	3120
	D	205	37	7870	1190	4220	2590	3350	2170	5200	3570	4330
	Average Classes A, B, C			3400	1210	1620	1380	1430	1630	2040	1800	1850
	Average Classes A, B, C, D			5050	1200	2580	1830	2140	1830	2210	2460	2770
June 1953	A	104	17	3260	1230	1540	1390	1320	1640	1950	1800	1730
	B	97	16	4770	1290	2270	1750	1750	1890	2870	2350	2350
	C	74	12	7570	1490	3580	2430	2500	2440	4530	3380	3450
	D	340	55	8450	1160	3920	3630	2910	2220	4980	4690	3970
	Average Classes A, B, C			4950	1320	2310	1800	1800	1940	2930	2420	2420
	Average Classes A, B, C, D			6880	1230	3200	2810	2410	2090	4060	3670	3270
July 1953	A	140	23	3240	1080	1490	1260	1330	1470	1880	1650	1720
	B	86	14	4610	1340	2290	1890	1830	1920	2870	2470	2410
	C	66	11	7540	1310	3510	2310	2390	2250	4150	3250	3330
	D	321	52	7930	1150	3270	3740	3060	2140	4460	4730	4050
	Average Classes A, B, C			4580	1210	2190	1680	1730	1780	2760	2250	2300
	Average Classes A, B, C, D			6320	1180	2850	2750	2420	1970	3640	3540	3210
August 1953	A	38	7	2910	1190	1440	1050	1320	1550	1800	1410	1680
	B	38	7	3500	1180	1980	1410	1470	1620	2420	1850	1910
	C	28	5	5250	1080	2610	1650	2340	1740	3270	2310	3000
	D	468	81	7650	1000	4610	3890	2430	1950	5560	4840	3380
	Average Classes A, B, C			3740	1160	1900	1320	1630	1630	2370	1790	2100
	Average Classes A, B, C, D			6910	1030	4100	3400	2280	1890	4960	4260	3140
Sept 1953	A	52	10	2480	970	1280	1140	1050	1280	1590	1450	1360
	B	59	11	2670	920	1620	1050	1400	1250	1950	1380	1730
	C	29	6	3810	990	2409	1390	1890	1470	2970	1870	2370
	D	377	73	6650	790	5680	3530	2540	1620	6510	4360	3370
	Average Classes A, B, C			2780	970	1700	1150	1370	1320	2050	1500	1720
	Average Classes A, B, C, D			5610	840	4610	2890	2220	1540	5310	3590	2920
Oct 1953	A	81	17	1200	510	570	560	560	660	720	710	710
	B	22	5	2000	720	1360	970	1220	970	1610	1220	1470
	C	9	2	2930	870	2500	1250	1730	1240	2870	1620	2100
	D	368	76	5210	650	6350	2980	2810	1300	7000	3630	3460
	Average Classes A, B, C			1500	610	920	730	810	800	1110	920	1000
	Average Classes A, B, C, D			4320	640	5050	2440	2330	1180	5590	2980	2870
Nov 1953	A	205	37	1130	510	640	550	600	650	780	690	740
	B	50	9	2040	740	1630	1140	1000	990	1880	1390	1250
	C	28	5	2470	720	2410	1460	920	1030	2720	1770	1230
	D	265	49	3080	560	5190	2360	1570	950	5580	2750	1960
	Average Classes A, B, C			1430	580	990	750	710	760	1170	930	890
	Average Classes A, B, C, D			2240	570	3650	1540	1130	850	3330	1820	1410
Dec 1953	A	211	39	820	370	470	420	440	470	570	520	540
	B	55	10	1590	600	1300	800	940	800	1500	1000	1140
	C	40	7	1980	660	1900	1030	1140	910	2150	1280	1390
	D	239	44	2350	510	4290	1660	1350	800	4580	1950	1640
	Average Classes A, B, C			1100	460	790	570	620	600	930	710	760
	Average Classes A, B, C, D			1650	480	2330	1050	940	690	2540	1260	1150

were made, designated as cloudy, partly cloudy, and clear.

3. Sky cover, in tenths, for the entire month.

4. Sky cover, in tenths, for the days for which recordings were made.

5. Percentage of the total number of readings, 8 a.m. to 5 p.m. designated as being in classes A, B, C, and D.

This table indicates that the distribution of cloudy, partly cloudy, and clear days for the recorded periods is just about the same as for the entire year. The table also indicates that the days designated as cloudy by the U. S. Weather Bureau are not all overcast days. On the average, it takes the sum of Class A, Class B, and Class C conditions to equal approximately the percentage of days designated as cloudy.

To obtain maximum information from these data, they have been tabulated in several different ways. Each tabulation will be presented and explained in the following sections.

In the consideration of the increase in vertical surface illuminations due to light reflected from a foreground, it has been assumed that (1) the quantities measured included a negligible amount due to ground reflection because of the black shield, and (2) for a foreground with a reflectance of 25 per cent, the increase in north, south, east, and west vertical surface illuminations would equal 12.5 per cent of the horizontal surface illumination.

Time-Intensity Graphs

In the daylighting of schools, offices, small factories, shopping centers, and the like, it is of interest to know what percentage of the time of occupancy the exterior illumination of a particular surface is above a specific value. Such a presentation has been made for the periods 8:30 a.m. to 3:30 p.m. for the entire year, and for the school year (September through May), and for 8 a.m. to 5 p.m. for the entire year. In plotting these data, the morning and afternoon values for east and west exposures have been kept separate. These data are presented in Figs. 3 to 8 as follows:

Figure	Coverage	Foreground Reflectance
3	8:30 a.m. to 3:30 p.m. — School Year	Negligible
4	8:30 a.m. to 3:30 p.m. — School Year	25 per cent
5	8:30 a.m. to 3:30 p.m. — Entire Year	Negligible
6	8:30 a.m. to 3:30 p.m. — Entire Year	25 per cent
7	8:00 a.m. to 5:00 p.m. — Entire Year	Negligible
8	8:00 a.m. to 5:00 p.m. — Entire Year	25 per cent

Average Illumination

The average illuminations for classifications A, B, C, and D, for the period 8:30 a.m. to 3:30 p.m., were calculated for each month. These averages for each exposure, without and with consideration of ground-reflected light, are presented in Table II. This table also shows the average illumination for each exposure for the sum of Classes A, B, and C and for the sum of Classes A, B, C, and D. The averages are weighted on the basis of percentages of time involved.

The average illuminations for all conditions for the period 8:00 a.m. to 5:00 p.m. are given in Table III, again without and with consideration of ground-reflected light.

Overcast and Cloudy Sky Conditions

Overcast and cloudy sky conditions are of particular interest because it is generally considered that for these periods exterior illumination is inadequate for daylighting purposes. This opinion is prevalent in connection with the daylighting of schools. Table IV shows the average external illuminations for each month for the school period 8:30 a.m. to 3:30 p.m., for the overcast, and cloudy sky conditions. Overcast sky conditions are represented by Class A and cloudy sky conditions, by Classes A, B, and C. The vertical surface illumination is given as the average of the values for north, south, east, and west exposures.

TABLE III — Average Illumination in Footcandles
8:00 a.m. to 5:00 p.m.

Month	Horizontal	Foreground Reflectance — Neg				Foreground Reflectance — 25%			
		North	South	East	West	North	South	East	West
Jan 1954	1140	420	1420	630	680	560	1560	770	820
Feb 1954	2120	530	2640	1130	1300	790	2900	1390	1560
March 1953	3450	840	2530	1660	1680	1270	2960	2090	2110
April 1953	4560	860	2650	1900	2150	1430	3220	2470	2720
May 1953	4920	1110	2140	1850	2050	1720	2750	2460	2660
June 1953	6180	1120	2800	2750	2580	1890	3570	3520	3350
July 1953	6190	1130	2680	2770	2690	1900	3450	3540	3460
August 1953	6400	980	3750	3150	2710	1780	4550	3950	3510
Sept 1953	5050	760	4260	2770	2660	1390	4890	3400	3290
Oct 1953	3900	570	4660	2050	2510	1060	5150	2540	3000
Nov 1953	2020	475	2720	1150	1230	730	2970	1400	1480
Dec 1953	1470	420	2170	870	910	600	2350	1050	1090
Avg	3950	770	2870	1890	1930	1260	3360	2380	2420

TABLE IV — Average Illumination
Overcast and Cloudy Sky Conditions — 8:30 a.m. to 3:30 p.m.

Month	Class A Avg V.S.I.* Neg Grd (fc)	Class A Avg V.S.I.* 25% Grd (fc)	Class A Avg H.S.I.** (fc)	Classes A+B+C Avg V.S.I.* Neg Grd (fc)	Classes A+B+C Avg V.S.I.* 25% Grd (fc)	Classes A+B+C Avg H.S.I.** (fc)	Class A H.S.I./V.S.I. Neg Grd	Classes A+B+C H.S.I./V.S.I. Neg Grd
Jan 1954	360	450	720	440	550	900	2.00	2.04
Feb 1954	580	720	1140	700	870	1390	1.97	1.99
March 1953	940	1220	2200	1160	1480	2580	2.34	2.22
April 1953	1060	1380	2590	1350	1760	3310	2.44	2.45
May 1953	1130	1470	2740	1410	1830	3400	2.42	2.41
June 1953	1370	1780	3260	1810	2430	4950	2.38	2.73
July 1953	1290	1680	3140	1700	2270	4580	2.43	2.69
August 1953	1250	1610	2910	1500	1970	3740	2.33	2.49
Sept 1953	1110	1420	2480	1300	1650	2780	2.24	2.14
Oct 1953	550	700	1200	770	960	1500	2.18	1.95
Nov 1953	580	720	1130	760	940	1430	1.95	1.88
Dec 1953	430	530	820	610	750	1100	1.91	1.80
Avg. Entire Year	890	1140	2030	1130	1460	2640	2.22	2.23
Avg. School Year	750	960	1670	940	1200	2040		

*V.S.I. — Vertical Surface Illumination.
**H.S.I. — Horizontal Surface Illumination.

Table IV also gives the ratio of horizontal surface illumination to vertical surface illumination for each month.

Sun and Clear Sky Conditions

It is also of interest to consider the variation in exterior illumination for a cloudless day. One day each month was selected as being the best from this point of view, and the data were plotted. Four of these graphs are presented as follows:

Fig. 9	March 20, 1953
Fig. 10	June 23, 1953
Fig. 11	September 28, 1953
Fig. 12	December 16, 1953

These data were plotted without consideration of additional ground-reflected light.

As an indication of the total luminous energy that is incident directly on the specific surface during the period of one day, between the hours given, the area under each of these curves was measured, and the results, in 1000 lumen-hours, are listed in Table V. In Fig. 13, these same values of total luminous energy are plotted against noon-sun altitude for the day of measurement. The altitude scale is divided into two parts to separate the values for the two halves of the year. For convenience, the altitude scale is also divided into months with specific dates designated. The continuous curves are drawn to give some indication of the total luminous energy, 8:00 a.m. to 5:00 p.m., for any clear day of the year.

Exterior Daylight Intensities Of 1000 and 2000 Footcandles

In a paper[6] on the availability of daylight at Port Allegany, Pa., data were presented showing the number of hours per day, between 8:00 a.m. and 5:00 p.m., that the illumination of particular surfaces was above 1000 and 2000 footcandles for each month. To allow direct comparison of these data with the data for Ann Arbor, a similar analysis has been made of the Ann Arbor data. The results are presented in Fig. 14.

Discussion of Results

Some previous papers[7] on the availability of daylight and solar radiation have attempted to relate the average intensity for cloudy days to the average intensity for cloudless days through the percentage of possible sunshine. In the absence of percentage of possible sunshine figures for Ann Arbor, approximate values have been obtained by averaging the available figures for East Lansing and Detroit. Utilizing these figures, an attempt will be made to relate conditions for cloudy and cloudless days.

From Fig. 13 it is possible to determine the average illumination, I_m, for each month, 8:00 a.m. to 5:00 p.m. for each exposure, assuming that all days are cloudless or reasonably so. Then, the average illuminations shown in Tables II and III can be

TABLE V — Total Luminous Energy
1000 Lumen-Hours
Sun and Clear Sky — 8:00 a.m. to 5:00 p.m.

Date	South	East	West	Horizontal
Jan 22, 1954	51.6	16.1	18.1	24.2
Feb 17, 1954	54.5	20.1	22.7	34.2
March 20, 1953	52.1	30.4	27.5	54.3
April 21, 1953	37.6	27.8	29.4	69.3
May 28, 1953	31.8	33.0	24.5	76.5
June 23, 1953	25.9	31.2	25.0	78.5
July 24, 1953	33.2	34.7	29.7	77.7
August 20, 1953	41.3	32.6	32.6	66.8
Sept 28, 1953	53.7	28.2	28.5	50.8
Oct 29, 1953	58.1	20.4	24.9	35.7
Nov 17, 1953	49.7	17.0	17.8	25.2
Dec 16, 1953	47.5	14.2	15.6	20.5

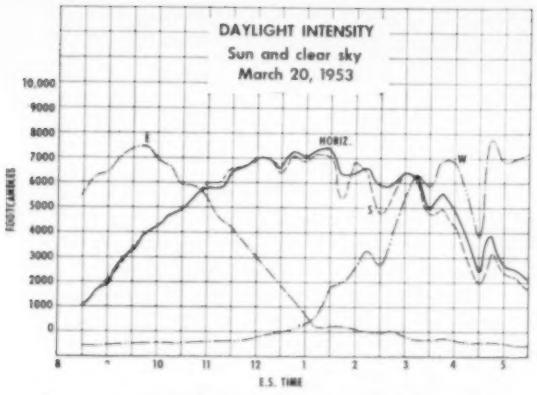

Figure 9. Daylight intensity. Sun and clear sky. March 20, 1953.

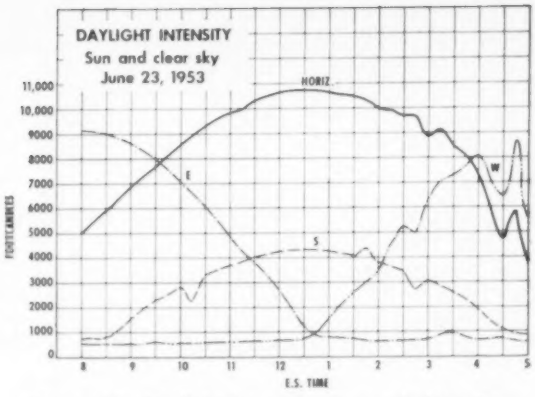

Figure 10. Daylight intensity. Sun and clear sky. June 23, 1953.

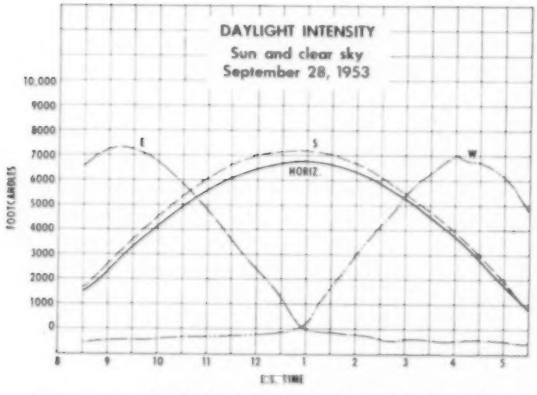

Figure 11. Daylight intensity. Sun and clear sky. September 28, 1953.

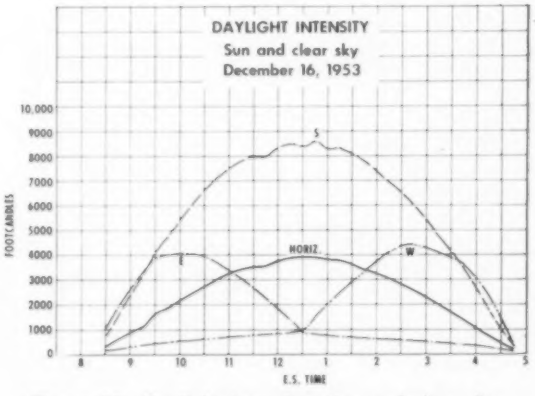

Figure 12. Daylight intensity. Sun and clear sky. December 16, 1953.

TABLE VI — Comparison of Cloudy and Cloudless Days
8:00 a.m. to 5:00 p.m.

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Per Cent Possible Sunshine	31	44	38	43	52	70	75	76	75	70	40	32
Avg Noon Sun Alt	27.5	35	46	57	66	70.5	69	62	51	40	30	25.5
Horizontal Surface												
I_o	2700	3720	5500	7280	8250	8640	8560	7670	6250	4670	3110	2310
R_1	0.23	0.30	0.38	0.33	0.32	0.34	0.36	0.36	0.36	0.23	0.33	0.32
R_2	0.29	0.36	0.44	0.42	0.40	0.52	0.53	0.45	0.40	0.29	0.42	0.43
R_3	0.42	0.57	0.63	0.63	0.60	0.72	0.72	0.83	0.81	0.83	0.65	0.64
South Vertical Surface												
I_o	5600	5900	5640	4560	3600	3170	3420	4420	5450	6170	5840	5280
R_1	0.068	0.103	0.16	0.22	0.27	0.42	0.41	0.30	0.22	0.086	0.098	0.083
R_2	0.094	0.143	0.23	0.32	0.37	0.64	0.60	0.39	0.29	0.138	0.150	0.140
R_3	0.25	0.45	0.45	0.58	0.59	0.88	0.78	0.85	0.78	0.76	0.47	0.41
East or West Vertical Surface												
I_o	1800	2300	2900	3170	3170	3170	3360	3560	3330	2750	2080	1670
R_1	0.144	0.26	0.31	0.33	0.35	0.44	0.41	0.35	0.35	0.20	0.25	0.23
R_2	0.171	0.31	0.38	0.42	0.44	0.58	0.54	0.43	0.40	0.27	0.31	0.32
R_3	0.28	0.53	0.58	0.64	0.62	0.84	0.81	0.82	0.82	0.83	0.57	0.53
I_o*	3200	4100	5000	5700	5600	5700	5000	6300	6000	5000	3670	2830
R_1*	0.109	0.134	0.19	0.18	0.20	0.24	0.21	0.17	0.19	0.112	0.15	0.15
R_2*	0.28	0.46	0.47	0.56	0.52	0.76	0.73	0.77	0.76	0.80	0.50	0.47

*For east in a.m. or west in p.m.

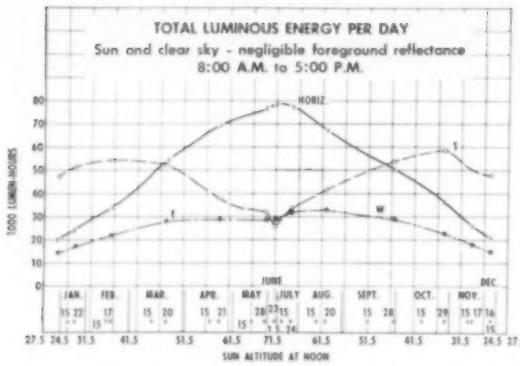

Figure 13. Total luminous energy per day. Sun and clear sky, negligible foreground reflectance. 8:00 a.m to 5:00 p.m.

related to these to obtain the ratios listed in Table VI, where R_1 is the ratio of the average illumination for strictly overcast sky conditions (Class A) to I_o, R_2 is the ratio of the average illumination for cloudy sky conditions (Classes A, B, and C) to I_o, and R_3 is the ratio of the average illuminations for all conditions to I_o.

Angström[8] has suggested that an equation of the form $Q/Q_o = a + bS$ represents the relation between sunshine, S (expressed as a fraction of the possible number of hours), and the ratio of the average radiation, Q, on a horizontal surface to the corresponding average radiation, Q_o, during cloudless days, where a and b are constants. Using the data of Table VI for a horizontal surface, it appears that

$$I = I_o\,(0.32 + 0.68\,S), \qquad (1)$$

is a reasonable expression, where I_o is the average illumination for the month, assuming all days to be cloudless, and I is the average illumination for the month having $100S$ per cent of possible sunshine. The values of I_o, $R_1 I_o$, $0.32 I_o$, $R_3 I_o$, and I for the 12 months are shown in Fig. 15. Setting $a = 0.32$ indicates that when $S = 0$ the sky is overcast and the average illumination is $0.32 I_o$. It appears that the agreement of $0.32 I_o$ to $R_1 I_o$ and I to $R_3 I_o$ is quite good, considering the uncertainty in S.

Reference to Table VI will indicate, however, that an equation of this form cannot be used to represent the conditions for a vertical surface since R_1 is not a constant or nearly so. An equation that represents fairly well the conditions for the south verical surface is:

$$I = I_o\,[S + 0.95\,(1 - S)\,\sin^2 \alpha/2], \qquad (2)$$

where α is the average noon sun altitude for each month. The values of I_o, $R_1 I_o$, $R_3 I_o$, $0.95 I_o \sin^2 \alpha/2$, and I for the 12 months are shown in Fig. 16.

A similar expression

$$I = I_o\,[S + 0.44\,(1 - S)\,\sin \alpha/2], \qquad (3)$$

represents the conditions for east exposure in the forenoon and for west exposure in the afternoon, values of I_o, $R_1 I_o$, $R_3 I_o$, $0.44 I_o \sin \alpha/2$, and I are given in Fig. 17.

Equations (1), (2), and (3) represent fairly well the data of Table VI, and were formed to give $I = I_o$ when $S = 1.0$, and average values for overcast sky conditions when $S = 0$. Equations (2) and (3) are for direct light only, and do not attempt to include an added vertical surface component due to ground-reflected light.

Since total radiation intensities were not measured at Ann Arbor or Willow Run during the period our data were collected, these daylight intensities cannot be related to total radiation.

When the distribution of brightness of an overcast sky has been measured, it can generally be represented by $B_\theta = B\,(a + b \sin \theta)$, where B_θ is the sky brightness at an altitude θ, B is the sky brightness at the zenith, and a and b are constants. It is because of such facts that Class A conditions were selected as those for which the ratio of maximum to minimum vertical surface illumination did not exceed about 1.5. Values of the constants a and b that have been used are $a = 0.4$, $b = 0.6$, and $a = \frac{1}{3}$, $b = \frac{2}{3}$. An integration of this expression for an unobstructed horizontal surface and for an unob-

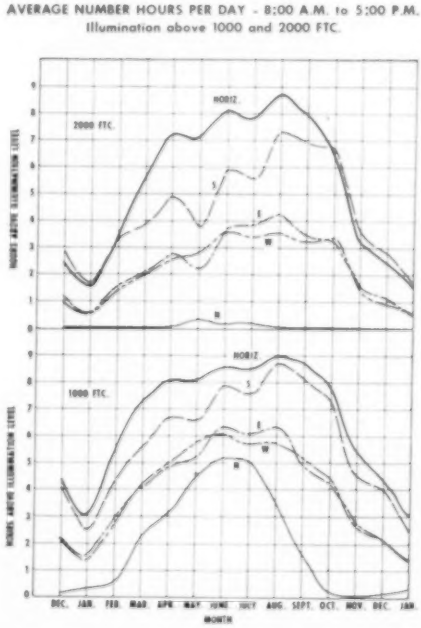

Figure 14. Average number hours per day — 8:00 a.m. to 5:00 p.m. Illumination above 1000 and 2000 footcandles.

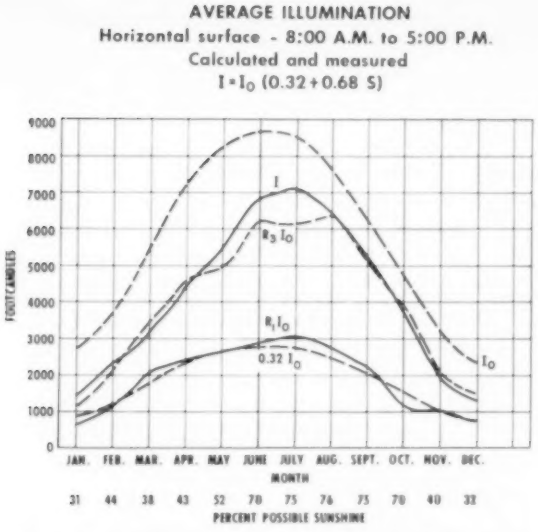
AVERAGE ILLUMINATION
Horizontal surface - 8:00 A.M. to 5:00 P.M.
Calculated and measured
I = I0 (0.32 + 0.68 S)
FOOTCANDLES
I
R3 I0
R1 I0
0.32 I0
I0
JAN. FEB. MAR. APR. MAY JUNE JULY AUG. SEPT. OCT. NOV. DEC.
MONTH
31 44 38 43 52 70 75 76 75 70 40 32
PERCENT POSSIBLE SUNSHINE

Figure 15. Average illumination. Horizontal surface — 8:00 a.m. to 5:00 p.m. Calculated and measured. $I = I_0\ (0.32 + 0.68S)$.

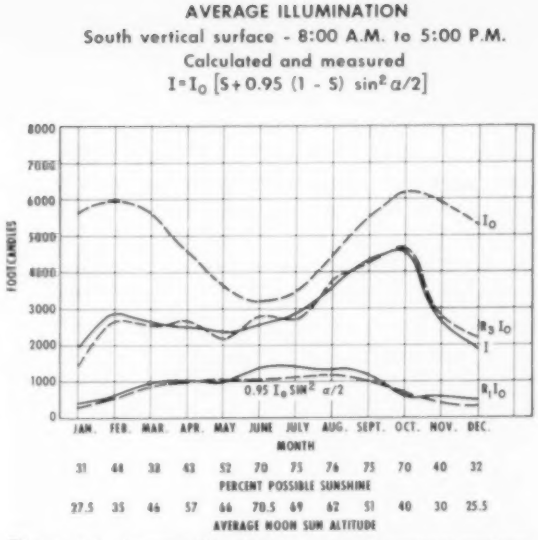
AVERAGE ILLUMINATION
South vertical surface - 8:00 A.M. to 5:00 P.M.
Calculated and measured
I = I0 [S + 0.95 (1 - S) sin² α/2]
FOOTCANDLES
I0
R3 I0
I
0.95 I0 SIN² α/2
R1 I0
JAN. FEB. MAR. APR. MAY JUNE JULY AUG. SEPT. OCT. NOV. DEC.
MONTH
31 44 38 43 52 70 75 76 75 70 40 32
PERCENT POSSIBLE SUNSHINE
27.5 35 46 57 66 70.5 69 62 51 40 30 25.5
AVERAGE NOON SUN ALTITUDE

Figure 16. Average illumination. South vertical surface — 8:00 a.m. to 5:00 p.m. Calculated and measured. $I = I_0\ [S + 0.95\ (1 - S)\ \sin^2 \alpha/2]$.

structed vertical surface gives a ratio for total horizontal to total vertical surface illumination of 2.42 and 2.52, respectively, for the two sets of constants. In Table IV such ratios are presented for average values of horizontal and vertical surface illumination for Class A conditions and for the sum of conditions of Classes A, B, and C. It will be observed that these ratios for the summer months agree quite well with the theoretical values. However, for the winter months the ratios are close to 2.0, which is the theoretical ratio for a sky of uniform brightness.

In the daylighting of buildings, the interior illumination is usually related to the exterior illumination of the surfaces containing the fenestrations. Some attempt has been made to establish average values for exterior illuminations due to overcast sky conditions; values of 500 and 1000 footcandles have been used for vertical surfaces, and 1000 and 2500 footcandles for a horizontal surface. The data of this study indicate that for strictly overcast sky conditions, and with average foreground reflectance, the average vertical surface illumination, between 8:30 a.m. and 3:30 p.m. is 1140 footcandles for the entire year and 960 footcandles for the school year. The corresponding figures for a horizontal surface are 2030 footcandles for the entire year and 1670 footcandles for the school year. For the period of 8:00 a.m. to 5:00 p.m. the figures, of course, will be somewhat lower. In any case, these data indicate that 1000 footcandles for a vertical surface and 2000 footcandles for a horizontal surface are reasonable averages for this location.

It should be realized, however, that minimum exterior illumination conditions do not only relate to overcast skies. Clear sky conditions for vertical surfaces not receiving direct sunlight or appreciable ground-reflected light should also be included. Comparison of Class D and Class A averages for north exposure in Table II indicates that

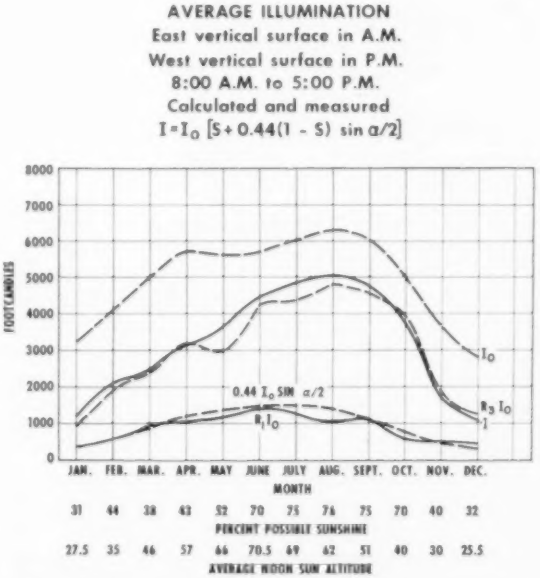
AVERAGE ILLUMINATION
East vertical surface in A.M.
West vertical surface in P.M.
8:00 A.M. to 5:00 P.M.
Calculated and measured
I = I0 [S + 0.44 (1 - S) sin α/2]
FOOTCANDLES
I0
0.44 I0 SIN α/2
R3 I0
R1 I0
I
JAN. FEB. MAR. APR. MAY JUNE JULY AUG. SEPT. OCT. NOV. DEC.
MONTH
31 44 38 43 52 70 75 76 75 70 40 32
PERCENT POSSIBLE SUNSHINE
27.5 35 46 57 66 70.5 69 62 51 40 30 25.5
AVERAGE NOON SUN ALTITUDE

Figure 17. Average illumination. East vertical surface in a.m., west vertical surface in p.m. 8:00 a.m. to 5:00 p.m. Calculated and measured. $I = I_0\ [S + 0.44\ (1 - S)\ \sin \alpha/2]$.

they are comparable. When the ground-reflected light is appreciable, the overcast sky conditions do represent the minimum.

One reason for establishing an average minimum exterior illumination is that for this value the interior illumination should be just adequate for the task involved. The percentage of time for which the exterior illumination, for all conditions, is above a specified level is given in Figs. 3, 4, 5, 6, 7, and 8. In the case of 1000 footcandles for a vertical surface and 2000 footcandles for a horizontal surface, Fig. 8 indicates that for the period 8:00 a.m. to 5:00 p.m. for the entire year, these values will be exceeded 67 per cent of the time for a horizontal surface and 75 per cent of the time for a vertical surface with south exposure.

In considering such figures, it should be realized that the data of this study are for one of the three districts in the United States having the lowest percentage of possible sunshine.

The U. S. Weather Bureau[9] extensively records solar radiation on a horizontal surface and collects illumination data at only a few geographical locations. More extensive data, showing total radiation and illumination for vertical surfaces, are required to obtain a correlation between solar heat and luminous energy intensities and atmospheric conditions. Recording devices designed specifically for such research are needed to avoid the time-consuming methods of tabulation and analysis used in presenting the data of this study.

Acknowledgement

The collection and initial tabulation of the data of this study were accomplished through the use of funds supplied by the Kimble Glass Co., a subsidiary of Owens-Illinois. The author is grateful to this company for its support and permission to use the data in this publication. The author also wishes to thank the Director of the Engineering Research Institute for making funds available for the preparation of the manuscript.

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1958 Conference Preprints Again Available by Mail

Despite the earlier date of this year's I.E.S. National Technical Conference — August rather than September — sets of preprints of papers being presented at the Conference will be available by mail practically at Conference time. The complete set of 1958 Preprints, including an estimated 37 papers, may be ordered in advance for delivery by mail, using the order form on page 58A of this issue or by including payment with advance Conference registration fees.

This mail service is primarily for those who will not attend the I.E.S. National Technical Conference, in Toronto, August 17 through 22, but who wish copies of the technical papers on latest developments in lighting theory, technique and application. Sets will be mailed to them as soon as available, at the usual price of $2.50, including mailing; 50¢ additional for shipment overseas.

Those attending the Conference in Toronto may purchase sets of preprints at the Registration Desk for $2.00 (cash-and-carry). Preprints to be picked up at the Conference should not be ordered in advance. An ample supply of preprint sets and order forms will be available in Toronto.

This plan for distribution of Conference papers was inaugurated last year and has proved satisfactory in simplifying sale of preprints at the Conference and reducing the volume of records needed. See page 58A of this issue for form to order your set of the 1958 I.E.S. National Technical Conference Preprints.

Daylight Illumination and Brightness With Minute Louvers

By WALKLEY B. EWING and R. L. BIESELE, JR.

DURING recent years, there has been a considerable increase in the use of minute-louvered materials to shade the exterior surface of window areas. The original purpose of these materials was to minimize the heat gain at the windows, particularly in the sunnier and warmer climates of the United States. Upon application, these materials have been found to have definite advantages as daylight control devices, as well.

By design, the materials admit light directly to an interior only from that portion of the sky which is near the horizon, and indirectly by reflection from the ground or other surfaces below the windows. Thus, they prevent the entry of direct sunlight to an interior, except for low sun angles in the early morning or late afternoon. They consequently reduce the quantitative variation in interior illumination between conditions of sun on the windows, and no sun, an effect which is most noticeable on partly cloudy days.

The materials also shield against the sky glare which is often associated with the upper portions of large window areas. They consequently improve the uniformity of the illumination and of the brightness pattern in the interior, by a greater proportionate reduction in daylight near the windows than at the opposite side of the room.

The minute-louvered materials are a fixed control, requiring no adjustment, yet they allow a free flow of natural ventilation. Most important, the small visual size of the louver elements causes them to blend into the outward view, reducing its apparent brightness, yet affording a clear view out, without the distracting pattern of light and dark stripes associated with larger louver elements.

As with any material, however, the minute-louvered materials can be used with greater or lesser effectiveness. It is the purpose of this paper to indicate some of the salient characteristics of the materials, together with discussion of their application, as a guide to more effective use of the materials in daylight control.

A paper presented at the National Technical Conference of the Illuminating Engineering Society, September 9-13, 1957, Atlanta, Ga. AUTHORS: President, Ewing Development Co., Grand Rapids, Mich., and Chief Servo Engineer, Fenwal Inc., Ashland, Mass., respectively.

Construction

The minute-louvered materials are available in several variations, which stem from different methods of fabrication. The first of the materials is of woven construction, in which the horizontal slats consist of thin ribbons of bronze, held at the proper spacing and tilt by the vertical members of twisted bronze wire. The entire material is chemically darkened. It is available in two basic constructions, which differ in spacing of the slat members as indicated in Fig. 1.

A second type is formed by slitting small segments of a thin aluminum sheet, and bending the slitted segments to form rows of the louver slats as indicated in Fig. 2 (a). Fig. 2 (b) shows the louver slats formed similarly, but to a somewhat larger scale, from a heavier aluminum sheet material.

Both the aluminum types exhibit reflections of relatively high brightness off their inner faces at certain sun angles. Consequently, the dark-slatted material appears to be preferable where visual tasks are critical, as in schools, offices, and certain industrial plants. The information presented here is therefore confined principally to this dark-slatted material.

Shading

The degree of shading of the darkened bronze materials is given in Table I. It will be noted that

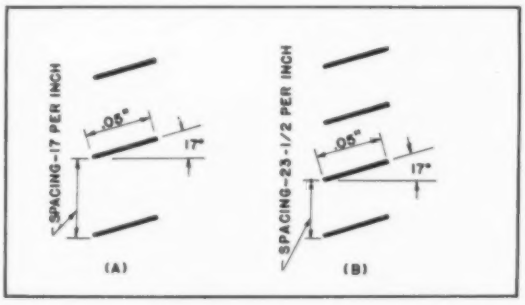

Figure 1. Cross section of minute-louvered material of darkened bronze. (A) Standard spacing. (B) Close spacing.

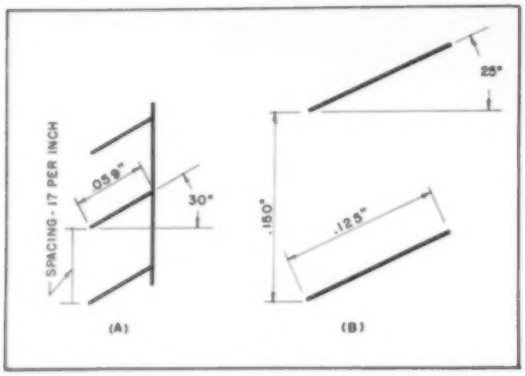

Figure 2. Cross section of minute-louvered material of sheet aluminum. (A) Screen Type. (B) Sun Shading Type.

complete solar shading extends to progressively lower sun angles (solar altitude) when the sun is at progressively greater sun-window azimuth angles. As with all fixed louver systems, shading is least effective when the sun is in the vertical plane at right angles with the plane of the louver material. As the table indicates, however, even when the sun is not completely shaded, the percentage of incident sunlight passing directly through the louvers is relatively small.

Shielding

The effectiveness of the minute-louvered materials as a brightness shielding device as viewed from the inside is directly related to the shading effectiveness. The curves of Fig. 3 indicate the proportion of the unimpeded exterior view which is actually visible between the slats for various lines of sight looking outward through the louvers. Although the interior surfaces of the darkened blades are not wholly black, the apparent brightness viewed along any particular line of sight will closely approximate the actual brightness along that line of sight (without interposition of the louvers) multiplied by the proportion of the unimpeded exterior view actually visible through the louvers.

TABLE 1 — Percentage Shading of Direct Sunlight by Darkened Bronze Minute-Louvered Screen, Standard Spacing.

Sun Altitude	Per Cent Shading for Sun-Window Azimuth of 0°	30°	60°
80°	100%	100%	100%
70°	100%	100%	100%
60°	100%	100%	100%
50°	100%	100%	100%
40°	99%	100%	100%
30°	79%	85%	100%
20°	65%	69%	80%
10°	55%	57%	66%

Illumination

The effect of the minute-louvered materials on the illumination pattern produced in the interior of a classroom is indicated in Figs. 4 and 5, which compare two classrooms on an overcast day. One room was equipped with the louvered material on the windows, the other had no controls on the windows, which were glazed with clear flat glass in each case. Based on equal exterior incident illumination, it will be noted that the result is a more uniform distribution of illumination, although at a low average level, in the room with the louvered control. The change in the distribution pattern produced by the louvered controls is the result of the selective shading of the direct skylight by the louvers, and their admission of reflected ground light, both of which tend to favor the inner portion of the room.

This comparison is quantitatively the least favorable to the louvered screen material, since with the overcast sky, no controls were required on the comparison room. With sun on the windows, it would be necessary to use some form of sun control on the windows in the comparison room, to prevent entry of direct sunlight. Under these circumstances, the quantitative comparison in illumination would be more nearly equal for the two rooms.

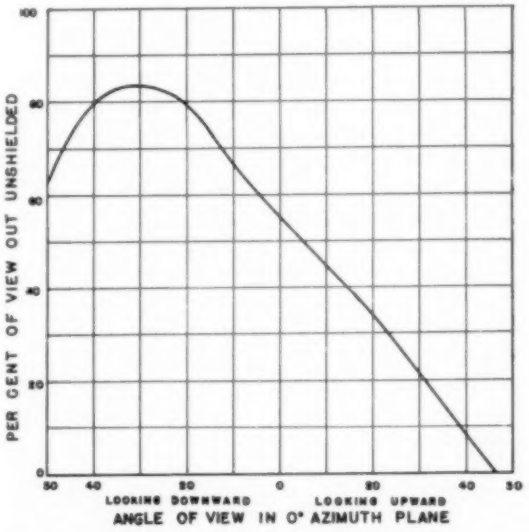

Figure 3. Per cent of view out, which is unshielded by minute-louvered material, standard spacing.

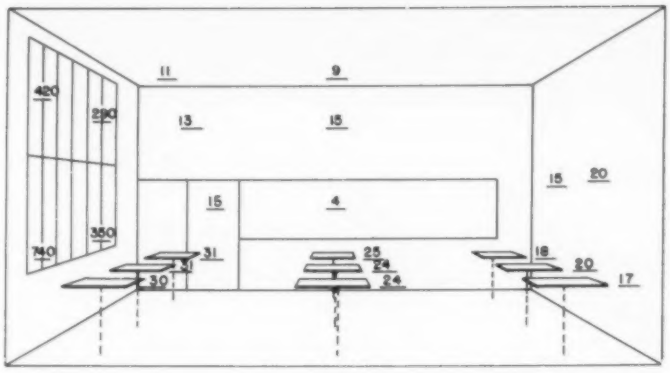

Figure 4. Test classroom at Hillcrest High School, Dallas, Texas, with minute-louvered material on clear glass windows, overcast sky, 1000 footcandles incident illumination on windows, of which 87 footcandles is from below the horizon. Values at desks are illumination, in footcandles. All other values are brightness, in footlamberts.

Brightness

The effect of the louver material on the brightness comparison of the same two rooms is also shown in Figs. 4 and 5. It will be noted that the brightness balance as viewed from the center-rear of the classrooms is more uniform in the room with the louver controls, although, again, at a reduced average level. With sun on the windows, and sun controls on the comparison room windows, the quantitative values would be more nearly the same.

The View Out

Perhaps the most significant advantage of the minute-louvered materials as a daylight control device is their inconspicuousness as viewed from the room interior. The louver elements are so small that they blend unobtrusively with the outside view, to the extent that the room occupant often is quite unaware of their presence. The effect is illustrated in Fig. 6. Larger louver elements, on the other hand, produce a strong pattern of light and dark stripes. The distraction pattern thus introduced not only attracts attention, but actually interferes with the view out. The large louver elements thus constitute a visual and a psychological barrier at the window, which can be avoided by the use of the minute-louvered materials.

Applications

(a) *Main Windows:* In applying the minute-louvered material to the main window areas of daylighted rooms, as in Fig. 7, several points should be considered by the designer. First, the reduction in total light passing through the louver material must be considered in the daylighting design. This can be compensated for either by increasing window area, or by greater use of supplemental electric lighting on dull days. Second, the effective shading period for direct sunlight should be determined for the particular orientation and for various times of the year, as a determination of the adequacy for the particular application. Third, in areas where winter days are usually overcast, as in the eastern Great Lakes region, design of the louver screens to permit removal during the winter months can be considered. If this is to be done, however, some form of auxiliary sun control must be provided on sun exposures, during periods when the louvers are removed.

Fourth, where possible, light colored pavements

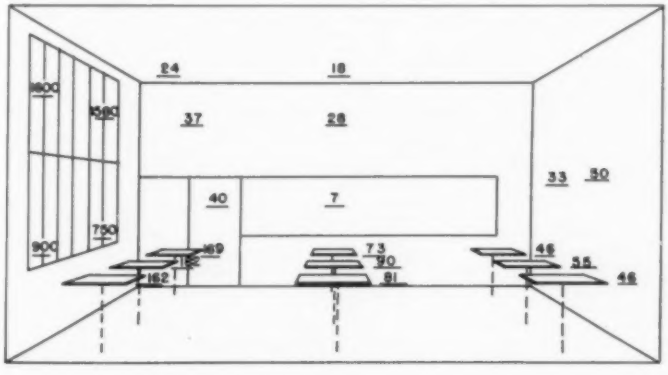

Figure 5. Identical comparison classroom, no controls on windows, to same base, same notation as in Fig. 4.

Figure 6. View showing inconspicuousness, coupled with effective control, of minute-louvered material

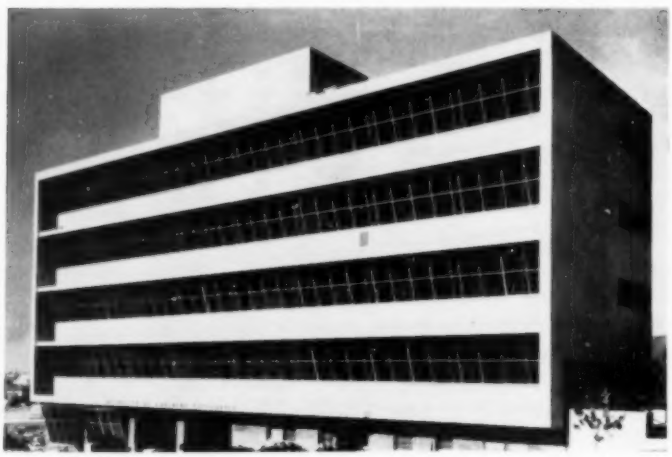

Figure 7. Minute-louvers on Medical Research Building, University of Southern California.

Figure 8. Minute louvers on vision strip windows.

Figure 9. Minute louvers on skylight, Colusa Elementary School, Colusa, California.

or other reflecting surfaces should be incorporated in the landscaping plan beneath the window areas, to take advantage of the selective transmission of the louvered material. Fifth, where sun control at very low solar altitude angles is essential, the louver materials can be mounted at an angle as in Figs. 7 and 8.

(b) *Clerestory Windows:* Clerestory windows, whether used in conventional clerestory building sections, as the auxiliary windows of bilateral daylighting building sections, or in roof monitors, are usually inaccessible from the floor. The use of the fixed louver material is advantageous when such windows are subject to direct sunlight, or to the high sky brightnesses found in some areas of the United States. Roof surfaces under such windows should be treated as reflectors, using white paint, aluminum paint, marble chips, or similar reflecting materials.

(c) *Vision Strip Windows:* Some forms of daylight control systems inherently prevent vision to the outdoors. Since the "view out" has been found to be desired in many interiors, "vision strips" are often employed with such daylight control systems. Where this daylight control system has been designed to reduce the window area brightness at normal viewing angles, it is desirable that the brightness of the vision strip be reduced to correspond. The minute-louvered materials have been used effectively, as in Fig. 8, to lower the brightness of the vision strip as seen from indoors, while still affording natural ventilation. Because of the di-

Figure 10. Classroom interior, Colusa Elementary School.

rectionally selective transmission of the louver material, this brightness reduction is also accomplished at greater net efficiency than could be obtained by the use of neutral gray tinted glass which is sometimes used for this purpose.

(d) *Top Lighting:* For top lighting purposes, the traditional skylight, using rough wire glass, has in hot, sunny areas had two major deficiencies, glare, and the admission of excessive amounts of heat. Heat absorbing glasses, with louvers below, have provided only a partial remedy. Louvers above the skylight have in the past had to be closed excessively, thus reducing materially the skylight admitted, in order to prevent direct sunlight from reaching the glass.

A novel application of the minute-louvered material, as shown in Figs. 9 and 10, permits the design of the louver above the skylight glass to be more open, to admit a higher proportion of skylight. The minute-louvered material employed for this application is the heavier aluminum sheet metal, which also admits some of the sunlight as diffuse, doubly-reflected light, without the admission of any direct sunlight. The louver material itself has been used, in effect, as a sort of diffusing, quasi-translucent louver slat.

Conclusion

As indicated, the minute-louvered materials have many desirable attributes for daylight control applications, in addition to their use as solar heat controls. Used with due consideration for their inherent characteristics, they afford another versatile tool for the designer of daylight control systems.

DISCUSSION

R. A. Boyd:* In Table I and Fig. 3 sufficient data are presented to calculate approximately the total transmission of the louver screen for overcast sky conditions. Has this been done? If so, is it consistent with the illumination and brightness conditions presented by Figs. 4 and 5?

Since these minute louvers are used in numerous ways for control of fenestration brightness and transmission of solar heat for direct sun conditions, it becomes highly desirable to have such performance data available. It is hoped that the authors will be able to present another paper, in the near future, containing more extensive data on performance.

*University of Michigan, Daylighting Laboratory, Ann Arbor, Mich.

Luminous Ceiling Plus Troffers in a General Office

Average illumination on desks after approximately 960 burning hours was 83 footcandles in the general office of Stanley Tools, New Britain, Conn. This is provided by a luminous ceiling system and perimeter troffers. The .015-inch thick vinyl chloride acetate ceiling material has a transmission factor of 45 per cent, a reflection factor of 53 per cent, and is suspended in 3- by 3-foot sheets by a series of suspension rods and supporting "V" channels, 9 feet from the floor. Single-lamp fluorescent strip above uses 40-watt standard cool white rapid start lamps. The recessed troffers each contain two similar lamps. Troffer panels are of .060-inch thick Plexiglas with transmission factor of 45 per cent and reflection factor of 53 per cent.

Lighting designed by Robert Chase, Power Engineer, Stanley Tools, New Britain, Conn. Installation was the entry of C. T. Travis, Jr., Benjamin Electric Mfg. Co., in the Connecticut Section's 1957 contest for My Most Interesting Lighting Job.

Control of Daylighting, With Reflecting Jalousies

By THOMAS CARSON

DAYLIGHTING a room from a single window wall introduces complications of light distribution, light intensity and brightness contrasts, which severely limit the geometry of the room. In the case of a classroom, where requirements of light distribution are strict, the floor width to ceiling height ratio is usually prescribed by code.

Architects have exercised a great deal of ingenuity in structural features, such as skylights and clerestory windows, and devices such as Venetian blinds, draperies, shades and fixed horizontal or vertical louvers, and have been able to improve greatly daylight distribution and brightness contrasts. However, the added expense, either first cost or maintenance, and the lack of adaptability to changing outside conditions, leave something to be desired in this field.

Purpose

This present paper is a report on an installation of reflecting jalousies, installed in the window wall of a classroom, on the outside of existing fenestration. This was done with four objectives in mind. First, we sought a re-distribution of light entering the work plane 30 inches from the floor. Second, we wanted to reduce the brightness contrasts that existed in the field of view. Third, we wanted a convenient means of reducing the total light in the room to a level that would permit the use of visual aid education equipment, and fourth, we wished to reduce the heat flow through the window wall.

Conditions

The room chosen for this study is the lecture room at the new Shuford Memorial Gymnasium at Lenoir Rhyne College, Hickory, North Carolina. The profile and plan are shown as Fig. 1. The room is 24 feet by 39 feet, with a 12-foot ceiling. One entire 39-foot wall is composed of windows. The windows start four feet from the floor, and extend to the ceiling. There are 13 windows, separated by box channel mullions. Each window has an 18-inch hopper vent at the bottom, and a 76-inch fixed light at the top. The windows are shielded by a two-foot overhang, two feet above the windows, and by a two-foot buttress of masonry at each end of the window wall. The interior walls are blocks, painted with a light non-glaring paint. The ceiling is white rough plaster. The floor is rubber tile. The window wall is oriented South 28 degrees West, and looks out upon a grass strip 30 feet wide, beyond which is a sand clay playing field.

The measurements shown in Table I were made with a Spectra Brightness Spot Meter. The Series I readings were made under three external conditions; with the hopper vents glazed with DSB, and the fixed lights of one-quarter-inch heat absorbing frosted patterned glass, with light transmission of about 40 per cent. The Series II readings were made with the heat absorbing glass removed, and replaced by an obscure patterned glass, with slight diffusing properties, and a light transmission of about 90 per cent. The Series III readings were made with the same conditions as Series II, except that the reflecting jalousies had been installed. The jalousies consisted of four-inch vanes of $^{7}/_{32}$-inch patterned glass, with metallic aluminum spray welded to the patterned side. These vanes were mounted on 3½-inch centers. Their light transmission is about 0.7 per cent, the reflectivity of the glass side about 85 per cent, and the reflectivity of the aluminum side about 80 per cent. The vanes were mounted so that the glass surface was turned out with the jalouisies closed, and up with the jalousies open.

Observations

Table I shows the comparative distribution of light between the diffusing glass condition (Series I) and the non-diffusing glass condition (Series II) and shows a considerable improvement in distribution. Note values C through H. The brightness contrast is also improved. Note differences between Series I, values B and I, and Series II, values B

A paper presented at the National Technical Conference of the Illuminating Engineering Society, September 9-13, 1957, Atlanta, Ga. AUTHOR: Director of Research, Blue Ridge Glass Corp., Kingsport, Tenn.

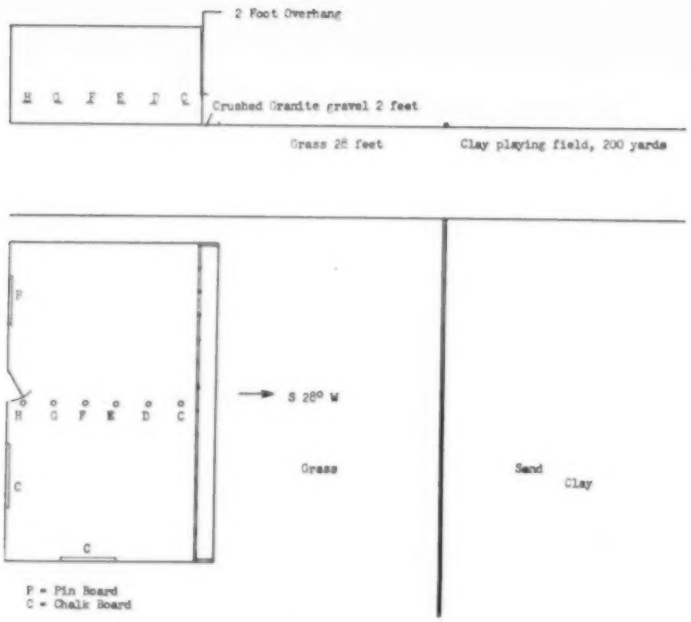

Figure 1.

TABLE I.

Series	Conditions	A	B	C	D	E	F	G	H	I
I	A — 9:30 AM, April 20, 1957 Overcast — no direct sun	2,000	550	170	120	80	70	55	40	50
	B — 2:00 PM, April 20, 1957 Overcast — no direct sun	2,900	800	200	150	100	85	75	55	30
	C — 3:00 PM, April 20, 1957 Scattered clouds — direct sun	5,800	1,600	380	280	200	150	120	90	90
II	A — 9:30 AM, May 26, 1957 Overcast — direct sun	2,800	3,800	220	180	120	85	70	60	55
	B — 3:00 PM, May 26, 1957 Scattered clouds — direct sun	6,000	15,000	4,000	800	300	120	80	50	120
	C — 3:30 PM, May 26, 1957 Scattered clouds — no direct sun	3,100	3,500	310	200	120	80	60	55	60
III	A — 9:30 AM, June 3, 1957 Scattered clouds — no direct sun, 90°	2,100	900	200	200	160	130	110	80	70
	B — 1:30 PM, June 3, 1957 Scattered clouds — no direct sun, 90°	3,000	1,000	220	220	180	150	110	90	75
	C — 2:00 PM, June 3, 1957 Scattered clouds — direct sun, 70°	6,600	1,100	250	220	180	150	130	120	75
	D — 3:30 PM, June 3, 1957 Scattered clouds — direct sun, 45°	5,500	1,200	250	245	220	175	160	140	80

Readings shown are in footlamberts.

Key to Table I

A — Brightness of opal glass, in the plane of the window, at the center of the window wall, divided by the transmission of the opal glass. This figure is the average effective brightness of the hemisphere that can see the window.
B — Brightness of window wall, from sitting position eye-level at the center of the room.
C — Brightness of bond paper (reflectance 73%), on desk at work level, 2 feet from window wall.
D — Brightness of bond paper (reflectance 73%), on desk at work level, 6 feet from window wall.
E — Brightness of bond paper (reflectance 73%), on desk at work level, 10 feet from window wall.
F — Brightness of bond paper (reflectance 73%), on desk at work level, 14 feet from window wall.
G — Brightness of bond paper (reflectance 73%), on desk at work level, 18 feet from window wall.
H — Brightness of bond paper (reflectance 73%), on desk at work level, 22 feet from window wall.
I — Brightness of front wall center, painted block, 70% reflectance.

and I. However, the installation of the reflecting jalousies has brought a further improvement in light distribution. The average ratio of brightest desk to darkest desk in Series II, excluding the desk which receives direct sunlight, is 5.2 to 1. The average ratio of brightest desk to darkest desk in Series I is 3.9 to 1. The average ratio of brightest desk to darkest desk in Series III is 2.85 to 1. This clearly shows that, if either diffusing glass (Series I) or non-diffusing glass is accepted as satisfactory, equal distribution could be achieved, with a higher ratio of floor to ceiling height, by the use of reflecting jalousies, and the cost of the room, per unit of area could be reduced.

In the consideration of brightness contrast, it must be realized that the vane angle can be adjusted to eliminate a direct view of the upper sky vault, which is of excessive brightness, by the cut-off angle of the jalousies, while retaining a view of the lawn, playing field, and low-brightness area of the sky vault near the horizon. The window wall with reflecting jalousies does have right much brightness, due to the interreflection between the top of one vane and the bottom of the vane above. Even under conditions of direct sunlight, however, this can be held to the comfortable level around 1200 footlamberts. The diffusing glass, however, may go much higher, particularly with a lower sun level than prevailed during these tests, and in the clear glass, the ultimate brightness of the brightest spot on the window wall is the sun itself. In addition, the general balance between the light in the area around the window wall, and the area opposite the window wall is a factor adding to the comfort of the room with the jalousie protection.

The third objective of this installation, that of achieving prompt blackout conditions for visual aid education, is readily achieved by completely closing the jalousies. This, in a classroom, would probably mean having the student nearest each operator close the jalousie. The light intensity is reduced to about one per cent of the normally incident light upon the window wall, and the room is uniformly lit by the dim brownish grey light that is transmitted through the vanes. There is sufficient light in the room for the teacher to maintain complete control, and for the students to make notes, to see and identify each other, but no area is sufficiently bright to distract from the visual aid screen. This particular installation was used successfully to study motion pictures of night football games, during the afternoon, with direct sun on the window wall. It is not likely that any visual aid program will be more demanding.

The study of reduction of heat flow, both solar

Figure 2.

Figure 3.

Figure 4.

Figure 5.

Figure 6.

heat gain in the summer, and heat loss in the winter has not been made, since the installation was only completed in May 1957. It may be noted in passing, however, that the occupants of the room report that the shading effect of the jalouies reduces the solar heat gain, and makes the room cooler. It is apparent that the closed jalousies during the winter nights, week-ends, and holidays will prevent direct impingement of the wind upon the windows, and will protect them with a blanket of still air. During the 75 per cent of the time that a classroom is not occupied, in winter months, this approximation to double glazing should make a difference in the cost of heating.

Conclusions

Reflecting jalousies can be installed in addition to conventional glazing, on classroom window walls. This may be attractive, and aesthetic as is indicated by the pictures, Figs. 2, 3 and 4. This results in a condition that removes the excess amount of light that falls into the work plane along the window wall, and reflects it into the ceiling, from which it is diffusely reflected into the entire room as shown by pictures in Fig. 5, without direct sun and Fig. 6, with direct sun, thus raising the light level along the wall opposite the windows. Such an installation improves the visual comfort within the room, by brightening the darker areas, and reducing the brightness of brighter areas. It can also be used as a quick and trouble-free means of blacking out the room for visual aid education. It will have some apparent, though unconfirmed benefits in reduction of heat flow through the window wall.

Acknowledgement

The author gratefully acknowledges the valued assistance of: Dr. Voigt Cromer, President of Lenoir Ryne College, whose concern for better classroom daylighting led him to make the building and facilities available, and to cooperate in the installation; Mr. Robert Clemmer of Clemmer and Horton, Architects, Hickory, N. C., for help on technical and aesthetic problems; Mr. A. M. Bartelt, Manager of Sales Engineering, Stanley Home Building Specialties, for designing and furnishing the jalousies that were used.

DISCUSSION

E. W. CONOVER:* It appears from the data given in Table I and other observations discussed that the objectives sought in this experiment have been accomplished. It is to be regretted that more tests were not run so that each type of glazing could be compared for the same time and weather conditions. In Table I, we question the sky conditions for Test II A, which specifies overcast and direct sun. We assume that the 90, 70 and 45 degrees shown in series III are the settings of the jalousie blades.

Although interior conditions have been made satisfactory, it seems that an objectionable feature has been introduced. Fig. 4 indicates that this window wall is quite bright and could be glaring with the sun shining on it. Fortunately, there are no buildings opposite, but if there were, we are under the impression that the neighbors would not be pleased. In the closed position this might be objectionable to occupants of the first floor of an opposite building and, when open, to those on upper floors. Although the surface of clear glass will produce this effect at certain sun angles, the back up of aluminum sprayed on the inner patterned surface seems to accentuate the problem.

*Fenestra, Inc., Detroit, Mich.

Automatic Processing of Photometric Test Data for Street Lighting Luminaires

By G. A. HORTON and P. A. ZAPHYR

MODERN HIGH speed digital computers can be programmed to perform many of the routine tasks involved in the processing and analysis of engineering and scientific test data. Over the past seven years various digital computers have been employed to process test data of asymmetric street lighting luminaires. The IBM Type 602A electro-mechanical calculator was originally employed to calculate the candlepower, lumen and footcandle values. Although extremely slow and awkward compared to modern digital computers, it was able to relieve valuable manpower from the routine tasks of analyzing data. The next computers to be employed were the IBM Type CPC computer,[1] and the IBM Type 650 computer which had definite advantages over the 602A computer. Recently a modern high-speed, internally programmed digital computer, the IBM Type 704, has been applied to the reduction of luminaire data.

This paper describes the processing of street lighting luminaire test data as programmed for the IBM Type 704 computer, and the plans now under development for the automatic recording of that test data. In addition, the calculations are reviewed and the results presented as recommended by the Illuminating Engineering Society.[2]

Luminaire Testing

In order to obtain illumination performance information for a given street luminaire design, it is necessary to test the luminaire's performance on a photometer.[3] Photometric readings are taken at intervals of 5° and 10° horizontal and 5° and 10° vertical about the luminaire except where the light intensity changes quite rapidly. This procedure applies for test luminaires having asymmetric light patterns. Since most modern luminaires designed for street lighting have somewhat the same light distribution pattern, it is possible to pre-specify the horizontal and vertical angles for which photometer readings are to be taken. Having obtained the photometer readings, a conversion factor to convert those readings to candlepowers is next obtained by methods described in the literature.[3] The next step is to obtain the overall efficiency of the luminaire by means of a photometric integrator.[3] All of these data are recorded on a data sheet which then forms the primary source of information for the computer.

So-called asymmetric street lighting luminaires do have symmetry of candlepower distribution about the vertical plane perpendicular to the direction of the street and through the center of the mounting pole. The horizontal (or azimuth angles are measured with reference to the plane of symmetry in the counter clockwise direction starting with zero on the street side and the vertical angles (or elevations) are measured in the upward direction starting with zero degrees at nadir. Let A represent the photometer reading obtained for a vertical angle V and horizontal angle H, and B the photometer reading for the vertical angle V and horizontal angle $(360°-H)$. Then by symmetry, A should equal B.[2]

Due to manufacturing variations the symmetrical readings A and B often do not always agree exactly, so in the analysis the variations are reconciled by working with the average photometer reading for pairs of symmetrical readings, *i.e.* $(A+B)/2$. The test data are recorded so that the symmetrical pairs of readings A and B are positioned next to each other and identified by the angles H and V; the horizontal angle $(360°-H)$ corresponding to the reading B is not recorded explicitly, but implied. Hence, one need only consider horizontal angles ranging from 0° to 180°. (See Table I.)

It is desired to evaluate the test data to obtain results which can then be compiled into a test report of the type recommended by the Illuminating Engineering Society.[2] The required results and corresponding calculations are summarized as follows:

1. The candlepower values for each combination of horizontal and vertical photometer readings are required. They are obtained by multiplying the averaged symmetrical readings,

A paper presented at the National Technical Conference of the Illuminating Engineering Society, September 9-13, 1957, Atlanta, Ga. AUTHORS: G. A. Horton, Westinghouse Electric Corp., Lighting Division, Cleveland, Ohio, and P. A. Zaphyr, Westinghouse Electric Corp., Analytical Department, East Pittsburgh, Pa. Accepted by the Papers Committee as a Transaction of the I.E.S.

TABLE I — Table of Horizontal and Vertical Angles Currently Used in Recording Asymmetric Luminaire Photometric Performance.

000	—
005	355
015	345
025	335
035	325
045	315
055	305
065	295
075	285
085	275
090	270
095	265
105	255
115	245
125	235
135	225
145	215
155	205
165	195
175	185
180	—

Vertical Settings of 0, 5, 15, 25, 35, 45, 55, 65, 70, 72.5, 75, 77.5, 80, 82.5, 85, 90, 95, 105, 115, 125, 135, 145, 155, etc. for each above horizontal setting

$(A+B)/2$, by the candlepower conversion factor, yielding the average candlepower for the associated horizontal and vertical angles.

2. The lumens in each 10° x 10° zone about the luminaire are calculated using lumen conversion factors[2] for spacings of 10° vertical and 10° horizontal.
3. Candlepower values are converted to footcandles on the surface of the street for all candlepowers with vertical angles less than 90°. The footcandle values are obtained by multiplying the corresponding candlepower values times the cosine cubed of the vertical angle and dividing by the square of the fixture mounting height in feet. Utilization of light from the fixture is obtained for ground surface areas on both the street side and the house side of the luminaire. This is done for lateral distances across the street of 0.5, 1, 2, 3, 4 and 5 times the mounting height, by the standard method described in the literature.[4] Utilization efficiencies for each of these ratios of lateral distance to mounting height are obtained by dividing the utilized lumens by the rated lumens of the bare test lamp. A plot of these utilization efficiency curves for both the house side and the street side is required information.
4. A plot of lines of equal illumination on the surface of the street is also required. This plot is called the iso-footcandle diagram and is required for each luminaire tested. For each plot, a table of correction factors for different mounting heights is also required.

Recording and processing the above data normally required about 30 technician hours for each test case. Steps 1 through 4 have been programmed for processing on the IBM Type 704 computer and the total elapsed time for the computer is approximately 13 minutes. In the following we shall discuss the computer program and shall attempt to give the reader an insight into the automatic processing of luminaire test data. Before doing this, it might be valuable to review some of the principles of operation of modern internally programmed digital computers.

Description of Modern Digital Computers

There are essentially five components in a digital computer: (1) the input devices whereby information can be brought into the computer, (2) the means by which the computer stores information, (3) the arithmetic unit which adds, subtracts, multiplies and divides numbers from the computer's storage, (4) the output devices whereby the results of the computer can be read out and printed and (5) the control unit which directs the operation of the computer.

Earlier computers received their instructions for operating on numbers stored in various storage devices externally and sequentially. The CPC is one of these externally programmed computers and such a computer has little versatility in choosing between several courses of procedure In comparison to these, the internally programmed computer contains all instructions in one of its various storage devices. The instructions are referred to in turn by the computer and the proper operations are then executed on numbers stored in its memory* devices. Further, the computer has the ability to choose between several courses of action and can refer immediately to the program describing the chosen course which is stored in its memory. This flexibility permits an internally programmed computer to perform almost any routine arithmetic task.

The IBM Type 704 computer is one of the most advanced commercially available digital computers (see Fig. 1). Its main memory consists of magnetic cores which can be referred to from the arithmetic unit in twelve microseconds. The computer program is stored in its main core memory which can contain up to 4096 instructions or data items in the present basic 704 model. In the near future 32,000

*The term "memory" when applied to computers refers to the units capable of storing information such as data and instructions for future reference by the computer.

Figure 1. Photograph of IBM Type 704 Computer.

core locations will be available. In the way of slower access storage devices the 704 computer has up to two magnetic drums, each of which can contain 8000 ten-digit numbers, and a bank of up to 10 magnetic tape units which can contain innumerable information. The primary input to the 704 is a card reader which interprets punched IBM cards at the rate of 150 cards per minute, and the main output is a printer which can print information stored in the computer's storage devices at 150 lines per minute. As reading cards and printing information is time consuming, magnetic tapes are used very effectively as input and output devices, since auxiliary equipment is available for transcribing information from cards to magnetic tapes and from magnetic tapes to printed information.

A program for a digital computer of this type is one which specifies a complete sequence of calculations including reading in of all information, instructions and data, and the printing out of all results. The utility of such program lies in the fact that once a sequence of calculations is programmed, it can be applied over and over again to innumerable sets of input data. The program which performs the required luminaire calculations outlined in steps 1 to 4 above is described next.

Luminaire 704 Program

Luminaire data, after being transcribed onto the test data sheet, are punched into standard IBM cards by key punch operators, the operation being much like typewriting. The card format, as currently specified, contains the symmetrical photometer readings A and B for the two combinations of horizontal and vertical angles in addition to test number identification. For most pendent luminaires the test readings range from 0° to 145° vertical and the corresponding approximately 900 readings are then contained in approximately 150 cards. This deck of cards is prefixed with one card containing the general data for the test, *i.e.*, the rated lumens of the test lamp, the mounting height of the fixture above the street surface, the efficiency obtained from the photometric integrator to be used as a check on the calculations and the factor for converting photometer readings to candlepower values.

All instructions, tables and other information required to perform the luminaire calculations are contained in a deck of cards called the program deck which is kept on file in the computer room. There are about 400 IBM cards in this program deck. When a job is received the test data are punched as described above and are placed behind the program deck. The combined deck is run through the IBM card reader and the calculations proceed automatically to give all results outlined in steps 1 to 4 above. About 13 minutes are required to obtain and print out all this information. The methods by which the computer processes the data and obtains the results are considered next.

Computer Method

On pressing the start button the computer begins reading the cards in the sequence in which they are placed in the card reader hopper. Since the first cards are the 400 program cards containing the detailed computer instructions, they are the ones which first enter the computer's main core storage unit. Having read in all program cards,

the computer then transfers control to the program unit. From this point on the program unit has complete charge of the operation of the computer and Fig. 5 displays in flow chart form the sequence of operations. Information which is loaded into the computer's main core storage is converted into binary form of representing numbers,[5] this system being the one in which the IBM Type 704 computer operates. After the first data card with its three values of horizontal and vertical photometer readings is loaded into the computer's main memory, the program proceeds to check the identification which is also loaded from this data card to see if it contains, (1) the correct test number by comparing that test number with the one obtained from the data card with the general information and (2) the correct sequence of horizontal and vertical angles. If either the test number or the horizontal and vertical angle sequences are incorrect, the computer will automatically stop, permitting the operator to make the necessary corrections and then proceed with the problem. However, if the check is satisfied, the computer then proceeds to calculate the candlepower for the three coordinates it has read. This candlepower value is then stored in the memory of the computer. Next, the program determines whether or not both horizontal and vertical angles are in the center of a 10° x 10° angular zone. If so, the lumens passing through that zone are calculated by referring to lumen conversion factors previously stored with the program in the main memory unit. The testing of the horizontal and vertical angles is performed by checking the low order digit of the angles to see if both end in the digit 5. If the angles do not satisfy this test, the lumen calculation is by-passed. This test is repeated for each of the angular readings for all data cards. Next, the computer checks each of the data cards for vertical angles to see if it is less than 90° and, if so, a footcandle value is calculated; otherwise, that calculation is bypassed. At this point, the information obtained thus far is printed out in one line per set of symmetrical readings (see Fig. 2), eleven sheets as shown being required. The footcandle values obtained are then stored in the computer's drum storage for reference in plotting the iso-footcandle curves. The next card is then read in and the computer goes through the same process. The first data card containing the general information is, of course loaded prior to the loading of the individual test data cards. Footcandles are calculated not by referring to tables, but instead, by calculating the cosine of the vertical angles and applying the factor cosine cubed divided by the mounting height squared to

LUMINAIRE TEST NO. K541054

Horizontal Angle	Vertical Angle	A Meter Reading	B Meter Reading	Candlepower	Lumens	Footcandles
000	000.0	1700	1700	5972.9		06.636611
005	000.0	1700	1700	5972.9		06.636611
015	000.0	1700	1700	5972.9		06.636611
025	000.0	1700	1700	5972.9		06.636611
035	000.0	1700	1700	5972.9		06.636611
045	000.0	1700	1700	5972.9		06.636611
055	000.0	1700	1700	5972.9		06.636611
065	000.0	1700	1700	5972.9		06.636611
075	000.0	1700	1700	5972.9		06.636611
085	000.0	1700	1700	5972.9		06.636611
090	000.0	1700	1700	5972.9		06.636611
095	000.0	1700	1700	5972.9		06.636611
105	000.0	1700	1700	5972.9		06.636611
115	000.0	1700	1700	5972.9		06.636611
125	000.0	1700	1700	5972.9		06.636611
135	000.0	1700	1700	5972.9		06.636611
145	000.0	1700	1700	5972.9		06.636611
155	000.0	1700	1700	5972.9		06.636611
165	000.0	1700	1700	5972.9		06.636611
175	000.0	1700	1700	5972.9		06.636611
180	000.0	1700	1700	5972.9		06.636611
000	005.0	2000	2000	7027.0		07.718983
005	005.0	2000	2000	7027.0	018.270	07.718983
015	005.0	2000	1980	6991.9	018.179	07.680388
025	005.0	2000	1920	6886.5	017.905	07.564603
035	005.0	1900	1900	6675.6	017.357	07.333034
045	005.0	1910	1900	6693.2	017.402	07.352331
055	005.0	1900	1880	6640.5	017.265	07.294439
065	005.0	1880	1810	6482.4	016.854	07.120762
075	005.0	1800	1780	6289.2	016.352	06.908490
085	005.0	1780	1710	6131.1	015.941	06.734813
090	005.0	1740	1700	6043.2		06.638325
095	005.0	1700	1680	5937.8	015.438	06.522541
105	005.0	1680	1620	5797.3	015.073	06.368161
115	005.0	1610	1600	5639.2	014.662	06.194484
125	005.0	1600	1590	5604.0	014.570	06.155889
135	005.0	1560	1540	5445.9	014.159	05.982212
145	005.0	1520	1520	5340.5	013.885	05.866427
155	005.0	1510	1500	5287.8	013.748	05.808535
165	005.0	1500	1500	5270.2	013.703	05.789237
175	005.0	1500	1500	5270.2	013.703	05.789237
180	005.0	1500	1500	5270.2		05.789237

LUMINAIRE TEST NO. K541054

Horizontal Angle	Vertical Angle	A Meter Reading	B Meter Reading	Candlepower	Lumens	Footcandles
000	135.0	0019	0019	0066.8		
005	135.0	0019	0020	0068.5	001.466	
015	135.0	0019	0019	0066.8	001.429	
025	135.0	0018	0018	0063.2	001.353	
035	135.0	0016	0017	0058.0	001.241	
045	135.0	0014	0015	0050.9	001.090	
055	135.0	0015	0014	0050.9	001.090	
065	135.0	0013	0016	0050 9	001.090	
075	135.0	0014	0014	0049.2	001.053	
085	135.0	0014	0016	0052.7	001.128	
090	135.0	0015	0016	0054.5		
095	135.0	0014	0016	0052.7	001.128	
105	135.0	0013	0018	0054.5	001.165	
115	135.0	0013	0019	0056.2	001.203	
125	135.0	0014	0021	0061.5	001.316	
135	135.0	0014	0021	0061.5	001.316	
145	135.0	0015	0021	0063.2	001.353	
155	135.0	0015	0019	0059.7	001.278	
165	135.0	0016	0018	0059.7	001.278	
175	135.0	0016	0017	0058.0	001.241	
180	135.0	0017	0017	0059.7		

Figure 2. Computer print out of luminaire data consisting of input data and calculated candlepower, lumen and footcandle values.

candlepowers at the various vertical angles.

Sixteen sums are accumulated as each card is being read. Twelve of these summations involve utilization of light on the street side and the house side for the six-each ratios of lateral distance across the street to mounting height, and the remaining four summations are concerned with the total lu-

LUMINAIRE TEST NO. K541054

INPUT DATA

Candlepower Factor	03.5135	
Bare Lamp Lumens	052000.	Lumens
Mounting Height	30.	Feet
Total Efficiency Check	66.50	Per Cent

UTILIZED LUMENS

Ratio	Street Side	House Side
0.5	07839.47	05664.50
1.0	13125.63	08873.19
2.0	17170.91	11355.65
3.0	18409.31	12151.02
4.0	18959.72	12523.39
5.0	19216.10	12710.42

UTILIZATION EFFICIENCIES IN PER CENT

Ratio	Street Side	House Side
0.5	15.08	10.89
1.0	25.24	17.06
2.0	33.02	21.84
3.0	35.40	23.37
4.0	36.46	24.08
5.0	36.95	24.44

SUM OF LUMENS BY QUADRANTS

	Street Side	House Side
Low	19905.50	13291.77
High	00702.65	00628.62

TOTAL LUMENS	034528.53	
CALCULATED TOTAL EFFICIENCY	66.40	Per Cent

Figure 3. Print out of computer summary sheet showing utilization efficiencies and final total efficiency of luminaire.

mens passing through each of the four quadrants about the luminaire. Thus, the computer must check the angles, see which quadrant they lie within, whether on the street side or house side or in the upper or lower hemispheres and then sum the lumens accordingly. Thus, when all data cards have been read and processed, the 16 summations contain the final accumulated lumens in the four quadrants and the accumulated utilized lumens for each of the six ratios on street side and house side. (See Fig. 3.) When the computer receives a blank card, it recognizes that as the end of the input test data and proceeds to print out the summary information. The summary sheet also contains the calculated total efficiency obtained by summing all lumens and dividing that number by the bare lamp lumen rating. This figure is compared with the total efficiency obtained from the photometric integrator and if the results compare sufficiently close, calculations may proceed. Next, the computer goes on to determine and print out the contour lines of light intensity on the surface of the street, that is, the iso-footcandle lines. (See Fig. 4.) The procedure employed in printing the iso-footcandle lines is described below.

Calculation and Printing of Iso-Footcandle Lines

Having processed all the test data, the drum contains a complete tabulation of footcandles for each combination of horizontal and vertical photometer readings. These values of footcandles are actually stored on the drums along with the horizontal and vertical angles with which they are identified for use in locating required footcandle values by interpolation. This process is as follows: Using the rectangular coordinates Y and X to represent the distance across the street and along the street respectively, transformation equations are set up from X and Y for the horizontal and vertical angles corresponding to the spherical coordinates of a ray emanating from the luminaire and projecting onto the street surface at any location X and Y. The computer program first sets up 120 coordinates on the street surface all having X equal to 0, that is, along the line perpendicular to the curb line of the street and through the mounting pole. The 120 Y values corresponding to each of the 120 X values are those for a distance of five mounting heights across the street and one on the house side in the same direction. (See Fig. 4.) Each of the 120 X-Y values are transformed to their corresponding horizontal and vertical angular values and, referring to the table of footcandles stored on the drum, the footcandles on the street surface are obtained by interpolation, Lagrange's interpolation formula[6] being used. This is a second order interpolation in two dimensions and consists of a two dimensional interpolation of angles. Usually a cluster of nine combinations of angles (for which there are already calculated footcandles) corresponding most closely to each of the required transformation angles mentioned above are checked. Each of the 120 values of footcandles thus selected are stored in sequential locations in the magnetic cores and the computer proceeds to search once for each specified contour curve whose footcandle values have been pre-loaded. Up to fifteen iso-footcandle curves may be prespecified for the computer to plot. The searching consists of examining each of the 120 footcandle values to see if it is greater than or less than the specified contour footcandle value. The outcome of this search is then compared with the outcome of a search for the preceding point; and if it is found that the two outcomes are different, that is, if on the first search the footcandle value is greater than the required contour footcandle value and on the second the footcandle value is less than this contour value, the computer places an alphabetic character corresponding to the contour curve in one of the 120 core locations set up for printing, the one being selected corresponding to one of the 120 Y values for which the condition of crossing was obtained. The computer then proceeds to examine the remaining points in

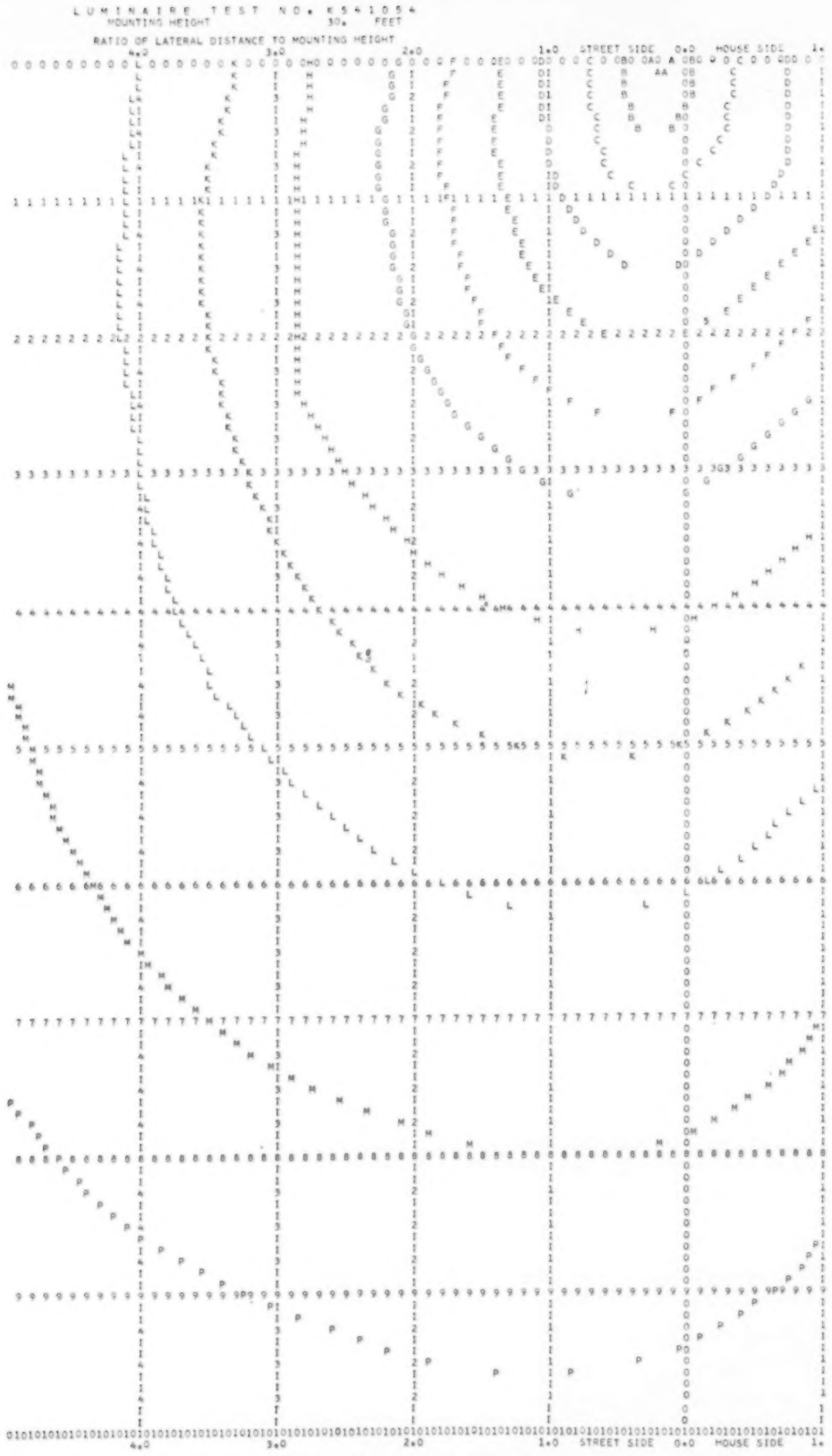

Figure 4. Computer print out of iso-footcandle plot. Vertical axis is the ratio of longitudinal distance to mounting height.

the same manner, placing alphabetic characters whenever a condition of crossing is found. This process is repeated for each of the 15 pre-specified footcandle contour values, each line of Y values across the street being interpolated and searched sequentially. The line of 120 characters to be printed out can be pre-loaded with information specifying the coordinates and when contour characters are assigned, they are super-imposed on the coordinate characters. That line is then printed and the computer proceeds to set up another such line for the next value of X. The process is repeated until it has gone sufficiently far down the street to permit an accurate and extensive isolux plot.

It should be mentioned in the above that 20 Y values correspond to one mounting height distance across the street. The reason for this choice is that it had been decided to use a two-inch space on the computer tabulating chart for each mounting height distance and printing across the chart contains ten positions per inch. The printing along the chart occurs at the rate of six printed lines per inch and again two inches in the longitudinal street direction correspond to one mounting height, so 12 Y values are required to print one mounting height distance along the street on the iso-footcandle diagram. The program is set up to print 120 X values or 10 mounting heights along the lines parallel to the curb. Thus there are 120 times 120 or 14,400 possible printing points on the iso-footcandle diagram.

Some mention should be made of the precision of the plot. Full scale in the direction across the chart is 12 inches with 10 characters per inch, so the resolution is one part in 120 or better than plus or minus one-half per cent. Full scale along the chart is 20 inches with 6 characters per inch so resolution is also one part in 120 or again plus or minus one-half per cent.

Having plotted the isolux curves the computer then prints a table of footcandle values for which the contours have been plotted and the associated alphabetical symbols or characters are included. It also prints a correction table giving the correction factor to be applied to the contour curves for a change in mounting height, the mounting height ranging from 18 feet to 35 feet. The iso-footcandle plot is well labeled with distances in terms of luminaire mounting height so that it can be readily used by anyone. Having completed one job the computer then is ready to read in the next case if one is available. If not, it stops automatically.

Automatic Recording of Test Data

Development is now under way to use analog and digital computing and recording devices to punch directly on paper tape the test data readings and to position the fixture and the photometer mirror in the test setup for automatic recording of data. A shaft position encoder is attached to the slidewire shaft of a microampere recorder to record photocell readings and a programmed punched tape will position the luminaire and mirror at a pre-specified sequence of horizontal and vertical positions. The program tape can be changed to specify another sequence of horizontal and vertical positions if it is so desired. It is expected that in the near future the automatic recording mechanism will be in full operation thus permitting a quick flow of information from the test center to the computer itself without any intermediate hand transcription of test data. It is expected that this will be the subject of a forthcoming paper.

Conclusions

Applications of computers both digital and analog in the recording and processing of test data have had phenomenal success. With newer and faster computers more and more of the work asso-

ISOLUX LINES OF HORIZONTAL FOOTCANDLES

Sym	Const fc	Sym	Const fc
A	7.50000	B	6.00000
C	4.00000	D	2.00000
E	1.00000	F	0.50000
G	0.25000	H	0.10000
K	0.05000	L	0.02500
M	0.01000	P	0.00500
R	0.00250	S	0.00100
T	0.00050		

CORRECTION TABLE

M.H.	C.F.	M.H.	C.F.
18	2.78	19	2.49
20	2.25	21	2.04
22	1.86	23	1.70
24	1.56	25	1.44
26	1.33	27	1.23
28	1.15	29	1.07
30	1.00	31	0.94
32	0.88	33	0.83
34	0.78	35	0.73

ciated with data reduction can be done to the advantage of all concerned. It is with this in mind that luminaire test data reductions have been programmed on high speed digital computers and the automatic recording of data is being developed. With the ability to quickly process information

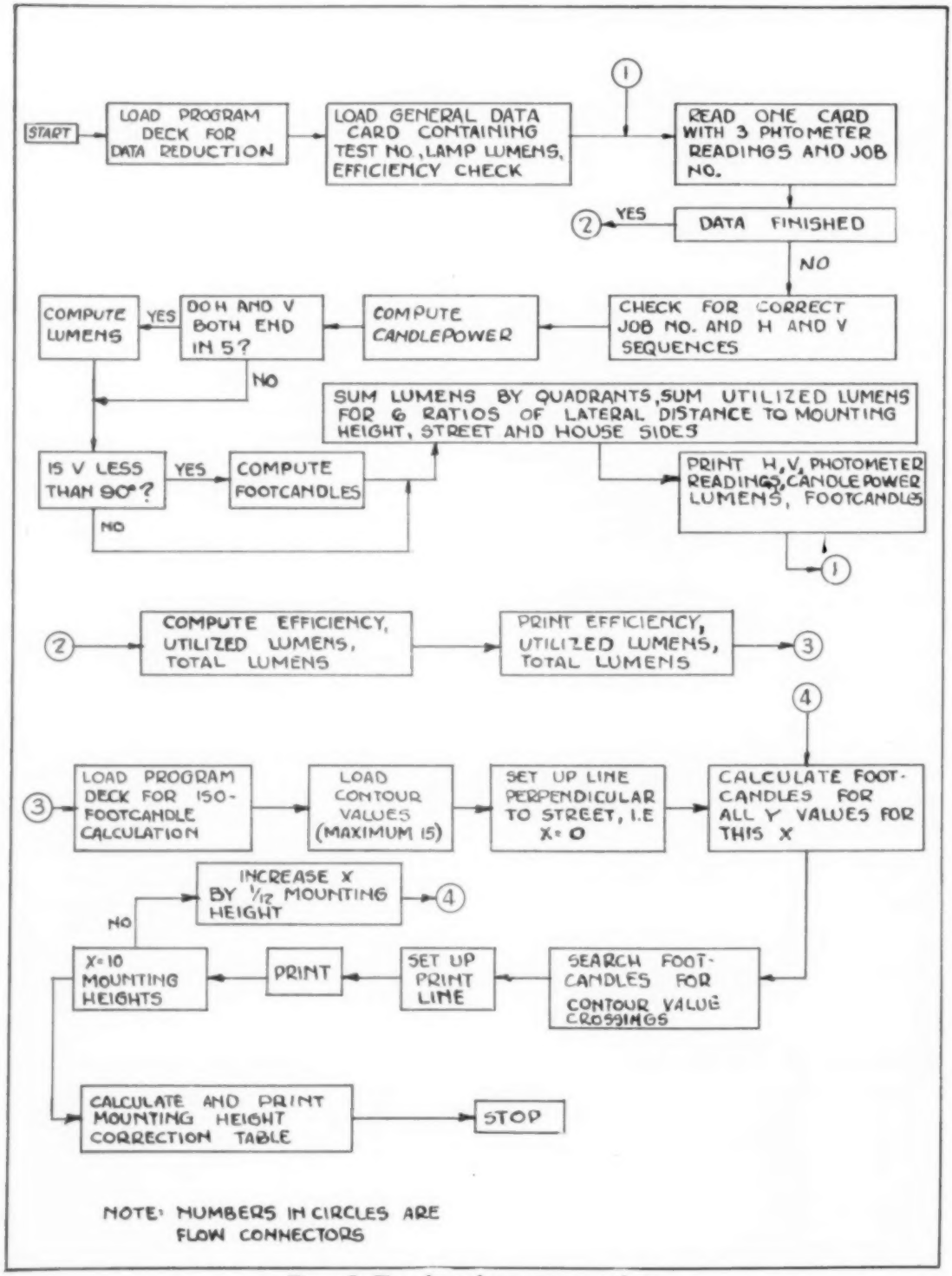
START
LOAD PROGRAM DECK FOR DATA REDUCTION
LOAD GENERAL DATA CARD CONTAINING TEST NO., LAMP LUMENS, EFFICIENCY CHECK
1
READ ONE CARD WITH 3 PHTOMETER READINGS AND JOB NO.
2
YES
DATA FINISHED
NO
CHECK FOR CORRECT JOB NO. AND H AND V SEQUENCES
COMPUTE CANDLEPOWER
DO H AND V BOTH END IN 5?
YES
NO
COMPUTE LUMENS
SUM LUMENS BY QUADRANTS, SUM UTILIZED LUMENS FOR 6 RATIOS OF LATERAL DISTANCE TO MOUNTING HEIGHT, STREET AND HOUSE SIDES
PRINT H, V, PHOTOMETER READINGS, CANDLEPOWER LUMENS, FOOTCANDLES
1
IS V LESS THAN 90°?
YES
NO
COMPUTE FOOTCANDLES
2
COMPUTE EFFICIENCY, UTILIZED LUMENS, TOTAL LUMENS
PRINT EFFICIENCY, UTILIZED LUMENS, TOTAL LUMENS
3
4
3
LOAD PROGRAM DECK FOR 150-FOOTCANDLE CALCULATION
LOAD CONTOUR VALUES (MAXIMUM 15)
SET UP LINE PERPENDICULAR TO STREET, I.E X = 0
CALCULATE FOOTCANDLES FOR ALL Y VALUES FOR THIS X
INCREASE X BY 1/12 MOUNTING HEIGHT
4
NO
X = 10 MOUNTING HEIGHTS
PRINT
SET UP PRINT LINE
SEARCH FOOTCANDLES FOR CONTOUR VALUE CROSSINGS
CALCULATE AND PRINT MOUNTING HEIGHT CORRECTION TABLE
STOP
NOTE: NUMBERS IN CIRCLES ARE FLOW CONNECTORS

Figure 5. Flow chart of computer operations.

and obtain detailed performance of luminaire design, the engineer is in position to obtain a better understanding of the factors that influence design, and is in position to conduct studies which heretofore have not been practical.

The data reduction and performance analysis is intended to be but a first step in a larger plan, one which in the future will encompass a complete design program on computers.

Acknowledgments

The authors wish to express their sincere thanks to Dr. E. L. Harder, Dr. B. H. Mount and Mr. R. L. Coates for their efforts in pioneering and developing many of the concepts employed in automatic luminaire data reduction. In particular, thanks are due to Mr. Coates who prepared the program for isofootcandle line printing. The technical advice of Mr. R. E. Wendt with regard to the automatic recording of test data is also deeply appreciated, also the services of Mr. R. C. Speck.

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DISCUSSION

W. B. ELMER:* The reduction in time of computation for I.E.S. street lighting data from 30 hours to 13 minutes, and the plan to use the computer technique in such rapid evaluation of luminaire performance as to become a design tool, appears to represent a triumph in the application of modern computers. In order to evaluate the significance of this work, it is hoped that the authors will include in their rebuttal to this discussion a statement of the true cost reduction which is not claimed by the authors, but is presumed to have been achieved in addition to the saving in elapsed time.

Should the I.E.S. Code adopt pavement brightness instead of illumination as the standard of street lighting performance, one wonders if the computers would still be equal to the task required of them. Presumably they would be capable of evaluating brightness analyses if fed sufficient pavement reflectance data.

The second paragraph under "Luminaire Testing" is no longer correct since the introduction of the new directional type of lighting for one-way streets and divided highways, which will undoubtedly be extensively applied, because of the greatly increased average visibility per footcandle provided by such lighting.

*Wheeler Reflector Co., Boston, Mass.

J. STUART FRANKLIN:* The use of digital computers in lighting design, calculation and test data is to be encouraged, provided they are soundly applied. Mr. Horton and Mr. Zaphyr are to be commended for pioneering their use in the reduction of photometric test data on street lighting luminaires.

The basic problem faced in this paper is the data taken during test, and the reduction of that test data to useful application engineering information. The authors have, so far, concentrated their efforts on the data reduction aspect of this dual problem. We, on the other hand, have devoted our primary interest to the test equipment needed to take the basic data.

The evaluation of many factors is involved before the decision to take a new course of action is settled. This whole problem is getting a new outlook from many groups. What are some of these factors?

(1) Cost of various methods.
(2) Time saved.
(3) Volume — data to be processed.
(4) Repetitious use of basic data.
(5) Complexity.
(6) Availability of digital computers and their associated equipment.

My discussion that follows is in no way to detract from the accomplishments of Mr. Horton and his associates, but simply to show that it is not to be expected that we all face similar problems; therefore our approach to similar problems requires diffierent solutions.

For example, over five years ago, in consultation with technical representatives of the IBM Corp., we decided not to apply our test data to digital computers for several reasons. It might be of interest to review some of these major objections.

(1) Availability. Our department had only an IBM 602 electromechanical calculator at the time. This required excessive card handling.
(2) Volume. The number of tests we completed per week would hardly warrant such an approach.
(3) Time. At that time it would have taken the machine approximately the same time to process — key punch, verify, calculate and print — as we were then taking to calculate on a desk calculator.
(4) Cost. Since machine time is more expensive per hour than technician time, the cost would have been greater.
(5) The complexity of the task, the lack of repetitious use of the data, and the inability to make special calculations at a later date, such as tilted luminaire performance, reduced the value of IBM processing.

For these reasons, we sought solutions along other lines than data processing. For the past four years we have had under development a new automated universal distribution (gonio) photometer. This is now under construction and is hoped to be the subject of a technical paper before this Society in 1958. This will permit a many-fold increase in test data in a given time over present test methods, and will automatically key punch the test data into IBM cards. This will solve the "volume" and "key punch, verify" problems. It also greatly reduces "test time." It will make possible a vast amount of test data, not economically possible at present. Therefore with a greatly expanded test facility, economical use of data processing equipment becomes possible.

Preparatory to completion of our new photometer, and to

*General Electric Co., Outdoor Lighting Department, Hendersonville, N. C.

gain valuable experience, we are now key punching test data directly into IBM cards by hand and processing our test data, for four types of luminaire distributions, on our own deaprtment's typical accounting-type data processing equipment — IBM 604 calculator, IBM 407 printer, etc. Programming is complete for symmetric (all four quadrants alike), symmetric (two quadrants different), totally asymmetric (all four quadrants different) and floodlighting type distributions. As we gain experience, procure more versatile data processing equipment, and complete installation of our new automated universal distribution photometer, we plan on programming more advanced problems dealing with visibility, comfort, design and customer applications.

So much for the overall problem presented by this paper. I should like to direct some more specific questions and comments to the authors.

It is good that they plan to automate one of their distribution photometers and plan on programming complete design problems on their computers. Both are steps in the right direction and all the industry should benefit from such a move.

I compliment the authors on the use of the term iso-footcandle *vs* isolux (except for the table associated with Fig. 4). Several other companies are now using this term and it is now used in the 1953 edition of the American Standard Practice for Street and Highway Lighting, which has the approval of the I.E.S. Council. It is used in the paper by R. G. McPhail, presented at the Conference by Kurt Franck. Its use in testing procedures guides, however, has been denied because it does not conform to approved I.E.S. nomenclature. This has been called to the attention of the Nomenclature Committee. It's time for a change.

Several minor points. How is Fig. 4 reduced to proper size for placing on the final tracing sheet? How much time does it take to make the reduction? Why is the mh correction table figured for each job, when it is a constant? Why do the authors allow footcandles to be calculated to six places to the right of the decimal, lumens three places, etc.? Why not let the machine do the rounding off in accordance with American Standard Practice and bring the number of significant figures in the answers more in line with the accuracy of the basic meter readings?

Thanks again for a very informative paper.

THOMAS H. LEISTER:* The authors have certainly achieved noteworthy progress in processing luminaire test data in minimum time. Addition of automatic recording to the processing of data will be of even greater significance. Their paper is most interesting.

The data obtained are very complete, and with a humorous thought, I believe the only item the authors have overlooked is the I.E.S. Type distribution. The method of using check points is excellent, as it eliminates the possibility of human error.

The next progressive step in lighting technology will probably be a change in the method of luminaire evaluation. That is, rather than speaking of horizontal footcandles, we will be taking into account the reflection factor of the surface to be illuminated. Any future method of evaluation, however, would be readily programmed for the computer.

I believe it would be of value to have an explanation of the constants that convert the lumens to effective lumens for the six given ratios of mounting height to transverse distances on the street surface. I would like to know how close the calculation of total efficiency and the efficiency obtained in the integrating photometer should be.

Application of the computer processing method in the lighting industry would depend much upon a manufacturer's ability to schedule and integrate other programs. Otherwise the computer would be economically impractical.

E. H. SALTER:* We at ETL are interested, always, in any means of reducing the cost of testing and of reporting test data. This paper would not only offer an assist in automatic testing, but also shows means of greatly reducing the time required for reporting. You may have noticed that in my second sentence I said time, while in my first sentence I said cost. In order to save this time, access must be had to equipment which in a situation such as ours may completely rule out any saving in costs. Where computing equipment is existent in a company for purposes other than purely computing photometric tests, the very use of the machine for computing these tests may be an overall economic move. However, where photometric computations would be the sole or main use for such equipment, it would appear that economy would rule out the computer under today's costs.

D. A. TOENJES:** The instrument technique that the authors describe appears to offer interesting and substantial savings in man-hours required to convert photometric data into the useful forms of candlepower distribution curves, coefficients of utilization, and iso-footcandle diagrams.

In future, such automatic processing could very likely be applied to other similar projects, such as the charting of pavement reflectance characteristics that has been the concern of our I.E.S. Committee on Street and Highway Lighting during the past few years.

From the paper it appears that the major advantage in the technique thus far lies in simplifying the calculations from the luminaire photometry, after the basic photometric data have already been measured and recorded. For a typical pendent luminaire, the authors indicated that the basic data would be contained in about 900 readings, on about 150 IBM cards. How long does it take the key-punch operators to convert the basic photometric data into these cards from the test data sheets? In other words, does this conversion now become the most time-consuming part of the total job? Also, where such a data-processing machine has multiple use, there is sometimes such a backlog of work waiting for it that its step in the data treatment becomes a "bottleneck" for many projects at once.

In the description of the calculation and printing of iso-footcandle lines it is not clear how the two-dimensional interpolations are accomplished. From the text of the paper we understand that the machine itself does this, by searching for data points both higher and lower than the contour value desired. Does the machine then simply print at a point midway between these two values? Or, instead, does it presume that the shape of the curve has been determined by some of the outlying points and then accordingly shift the exact position for printing within the span?

The authors have shown an iso-footcandle diagram on rectangular coordinates, as a typical chart plotted by the computer. Is it practical for this instrument technique to be applied also to the familiar "onion diagram" with its non-rectangular shape, for plotting iso-candle diagrams?

*Line Material Industries, Milwaukee, Wis.

*Electrical Testing Laboratories, Inc., New York, N. Y.
**Application Engineering, General Electric Co., Cleveland, Ohio.

JOHN O. KRAEHENBUEHL:* This paper brings to the attention of the Society the use of modern computers in the illumination field. In many instances some type of computer is available to the Illumination Division of an organization, in particular in utilities, and in very few instances are these put into service. With the paper calling the attention of the membership to a possible use of computers it may be that in the future others will note the advantages of programming and using the machines at hand. If proper attention is given to available equipment there is no doubt that, even if they are of a simple or more or less obsolete type, they still have possibilities. In most Utility Transmission Divisions there are network analyzers which may be turned into devices for the study of illumination problems and designs.

The paper describes the equipment used, the details of which will be furnished by the various manufacturers with as much expert advice and consultation as may be desired. The results desired are indicated by the specifications and problems in illuminating engineering. The item which is missing, which is the important one, is an explanation of programming, how it is done, *i.e.* how programs for specific illumination data and calculations are assembled for the various computers with examples for problems as outlined in the paper.

The Society should expect such information in future papers by the authors who introduced the technique to the organization.

G. A. HORTON:** The authors wish to thank all the gentlemen who discussed the paper.

In reply to Mr. Elmer, we have found that in our particular case the cost of the computer method of data reduction is approximately one-third that of the desk calculator method. We also feel that computer solutions will be possible should pavement brightness be adopted as the I.E.S. standard. The solution of unidirectional luminaires would require some reprogramming of the computer.

In reply to Mr. Franklin, the iso-footcandle lines are reduced to report size by means of a pantograph and this requires 15 to 20 minutes of a draftsman's time. The footcandle values are calculated to six places since the first significant figure actually appears in the fifth decimal place at high angles in some small luminaires utilizing lamps of small light output. The same reason applies to the lumen calculations.

The mounting height correction table is included in the calculations for the sake of completeness and to make each test self-contained so that a relatively inexperienced draftsman could draw up the final report sheet.

In reply to Mr. Leister, the constants which convert the luminaire lumens into lumens effective on the street surface were derived from Reference 4 at the end of the paper (Benford: "Isocandles," *Transactions, I.E.S.*, Feb. 1926).

For example, referring to page 153 of this article, we find Fig. 16, "Great Circles for tan $V_o = 1$ to 14." From the discussion given in the article, we know that the area on this iso-candle diagram bounded by the vertical line 90° to 0°, the hemisphere boundary 0° to 1.0, and the great circle 1.0 to 90° is the projection back on the isocandle diagram of a longitudinal strip on the street side street surface from directly beneath the luminaire to one mounting height distance across the street. Therefore, all the lumens passing through this zone on the sphere surface are utilized in the above mentioned strip. Since the lumens within all the 10° by 10° zones of the iso-candle are known from the routine photometric test procedure, it then becomes a problem of determining which of these zones and fractions thereof are being utilized. For example, we see that light passing through all the 10° by 10° zones centered on horizontal lines through 5°, 15°, 25° and 35° vertical are utilized. However, not all of the 10° by 10° zones centered on 45° vertical are utilized since the great circle 1.0 to 90° cuts through three of the zones. The utilization constants for these zones are:

Centers of Zones Horizontally	Vertical Angle 45°
5°	0.5
15°	0.6
25°	0.7
35°	1.0
45°	1.0
55°	1.0
65°	1.0
75°	1.0
85°	1.0

Utilized lumens for both street and house side may be worked out in this same manner.

We feel that the photometric accuracy is good if the calculated and measured luminaire efficiency agrees within plus or minus one per cent.

In reply to Mr. Salter, we wish to state that his assumption is correct that it is not likely that any photometric laboratory by itself could support an internally programmed, high power computer such as the IBM 704. However, smaller portable desk side computers are now becoming available which have speed and memory equal to computers many times their size and cost, and it appears it might be profitable to investigate the capabilities and limitations of this type of equipment.

In reply to Mr. Toenjes, we wish to state that he is correct in his statement that the savings in man hours are substantial and the technicians use this time to gather more basic data for reduction on the computer.

The computer calculations are exactly the same as used in the previous desk calculator method with the exception of the iso-footcandle plot which is complicated rather than simplified by the use of the LaGrangian interpolation.

It formerly required the key punch operator approximately one hour to punch the cards for one test, and a similar period for verification. However, this operation has now been eliminated as the photometer readings are automatically recorded in a punch tape and then transferred from the tape to the cards by means of a tape to card converter.

We have, luckily, never suffered from "bottlenecks" of computer availability as Mr. Toenjes suggests. Perhaps this is due to the fact that each test requires approximately only thirteen minutes.

As mentioned in the paper, there are 14,400 possible plotting points on the computer chart for the iso-footcandle plot. The computer calculates the rectangular coordinates for all these possible points and the footcandles for these same points are determined by the LaGrangian interpolation as mentioned in the paper. Once these footcandle values are all determined, the computer searches for the prescribed contour values, printing out at the position on the computer chart where the nearest values to the prescribed values are located. It is thus not always possible for the computer to find the exact position for printing, but only to approximate the position within its resolution of plus or minus ½ per cent. However, comparison of the hand plotted and computer plotted iso-footcandle diagrams show excellent agreement.

*Colorado College, Colorado Springs, Colo.
**Co-Author.

Conference Room . . .

from a beauty parlor

Although lighting cannot make "a silk purse from a sow's ear" it can, with its sister arts of architecture and interior design, make a conference room from almost anything. The two areas shown here were formerly a beauty parlor and a parking garage respectively. The problems encountered in converting them to conference rooms made them MMILJ's — and winning entries — for the engineers who accomplished their transformation.

When the Leo A. Daly Co., Architects and Engineers, started looking for space to use as a conference room, they found available an area in their building which had formerly been used as a beauty parlor. The area was of an odd shape and was divided into four small rooms, two of which had large windows looking out at the blank brick wall of the City Hall.

Since the room was intended for conferences with prospective clients, environment was a most important point. Other requirements were flexibility for either casual or difficult tasks, and provision of suitable facilities to display models and renderings and a place to show slides.

A team was assigned to the project — architectural designer, electrical engineer and mechanical engineer. The first decision was to blank off the windows, since nothing could be done about the brick wall, and create an illusion of outdoors by back-lighting the draperies.

Since environment factors required that sources of lighting be inconspicuous, a recessed system was chosen for both general and local lighting. An average maximum maintained level of 20 footcandles is provided by general lighting from 75-watt R30 floodlamps, recessed on 3-foot centers around the perimeter of the room, and a few similar units in the center of the room. Over the conference table, a maximum level of 150 footcandles is supplied by two recessed Alzak aluminum reflectors, each with a 300-watt clear lamp. Both general lighting and table lighting are on dimmers, for a wide range of illumination levels.

Horticultural as well as decorative advantage results from the lighting of the two large plants, which contribute to the over-all pleasing appearance of the room. These are lighted from below, since plants which have only top lighting are in-

clined to shoot upward in height and lose their lower leaves. A plant lighted from below will not grow nearly as rapidly and will almost always retain its lower leaves and full-bodied look.

Another decorative lighting technique is the backlighting of the draperies, from a continuous row of fluorescent strip recessed at the top of the window area. The recess is about two feet deep and was calculated to make it impossible to see bare lamps from any normal viewing position.

When the slide projector is in use, the draperies are parted, and the screen is pulled down from its ceiling recess. A switch at the projector shelf controls all the lighting in the room. Another demonstration facility is a table with a motor-driven top for display of models. The table top, which can turn continuously, is highlighted by a small adjustable spotlight.

Walls of the conference room are either panelled with rosewood or covered with rice cloth.

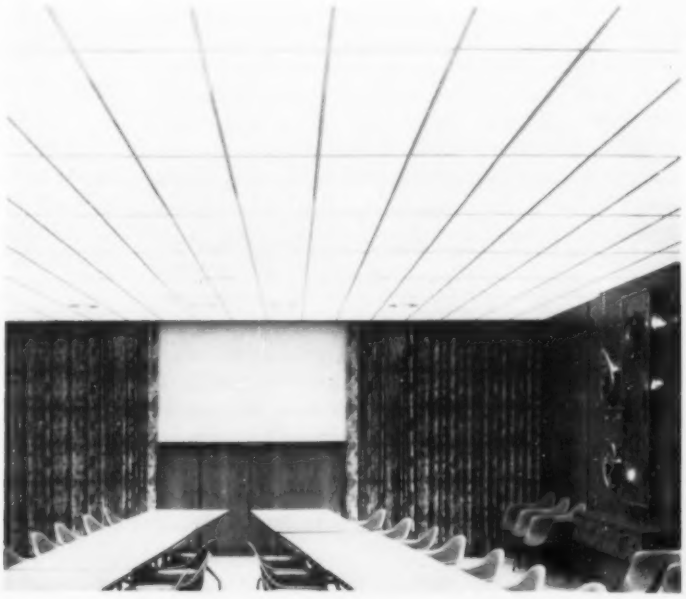
This "transformation" of a beauty parlor to a conference room won first prize in the Cornhusker Section's 1957 contest for My Most Interesting Lighting Job, and placed second at the Midwestern Regional contest. Lighting designed by E. C. Knudson of Leo A. Daly Co., Omaha, Neb.

and from a parking garage

Converted from the third floor of a parking garage, the conference room of the Southwestern Public Service Co., in Amarillo, Texas, has everything which can contribute to its various uses. Equipment for training, lectures, demonstrations and projection is combined with the lighting system and the heating and air-conditioning systems to utilize the room to maximum benefit.

General lighting in the 23x40-foot room is by a louverall ceiling, with eight rows of 40-watt cool white rapid-start lamps in channel on the ceiling, spaced on 2-foot 10-inch centers. Louverall panel sections with $\frac{3}{8}$-inch cells may be lifted out individually for re-lamping and maintenance. An average of 60 to 70 footcandles is provided.

Four adjustable 150-watt PAR spotlights are recessed in the louverall ceiling, for highlighting speakers and displays or focusing attention on the



When projector is not in use, draperies close on motorized system to cover front wall.

Decorative panels with engineering symbols.

front area of the room. These have 45-degree horizontal adjustment and 22½-degree vertical. Also above the louverall ceiling are the air-conditioning and heating ducts and openings, four recessed speakers for the sound system, and four 60-watt opalescent glass enclosed fixtures on a 360-watt dimmer for low brightness illumination or film projection.

Walls are paneled with semi-limed walnut, and front walls are covered with draperies incorporating, in the design reproductions of Public Service Central Office Building, two of the newest power plants and applications of typical electrical service. Decorative murals on side walls incorporate engineering symbols in vari-colored glass panels lighted from the rear with 7-watt lamps.

Other features which make the room adaptable to many uses are four microphone jacks, at the speaker's location, on the walls at the front and rear and in the center of the room. A recessed jack in the floor by the speaker's location provides facility for a signal light for slide film projection. In an adjoining storage room, there is a built-in elevated projection booth with 16 mm projector, record player and tape recorder. Here also is the equipment for the three-way switching on two rows of conference room lamps, the dimmer for projection lights, switch for the motorized curtain roll-back and control for the roll-up projection screen.

Wiring is by two 50-ampere range circuits with outlets available for appliance or equipment demonstrations. The room is heated and cooled by two 5-ton heat pumps with electronic air cleaning and germicidal lamps for air purification.

Architect, John Hannon; consulting engineer, Richard M. Steward; electrical contractor, Sam Cain; distributor representative, Frank Donahue. Lighting designed by Tom Lynn, lighting specialist, Southwestern Public Service Co., Amarillo, Texas. This installation won first prize in the Panhandle Chapter's contest for My Most Interesting Lighting Job.

I.E.S. Emblem

The official emblem of the Illuminating Engineering Society is available to members in 14-karat gold, lapel screw back buttons, in the miniature ½-inch size, at only $3.50 each including taxes. Background of emblem is blue for Members, red for Associate Members. Emblems may be ordered from the General Office, Illuminating Engineering Society, 1860 Broadway, New York 23, N. Y.

A Photographic Method of Brightness Recording

By C. AND E. MARSH

DURING A study of window design, we became interested in developing an improved method of brightness recording, as the success of a fenestration depends largely on the brightness patterns occurring in the room. The camera seemed a useful instrument for this since it can quickly collect a large amount of information. A technique for locating and measuring certain brightnesses photographically had been partly developed in earlier work on headlight beam patterns.[1] This technique has been expanded into a versatile and convenient method, useful for daylighting studies and other measurements as well.

An ordinary photograph by itself is of limited use in brightness studies. The negatives may be scanned with an instrument, but this process is tedious. The key to useful measurement lies in a technique for recording brightness contours which show all areas of that brightness present in the photograph.

These contours of equal brightness are produced by increasing the contrast of the negative until there is a sharp boundary without gradation between black and white areas of the photograph. At this boundary the contour will be found.

The contrast of the film is increased to this degree by printing and reprinting from the original negative onto a very high contrast film. The value recorded by the contour is determined by the time of exposure during this reprinting process.

To calibrate the contours, areas of known brightness are photographed, either within the scene under study or under identical conditions in a separate exposure. From readings of optical density at the image of this area of known brightness, the exposure for printing the high contrast negatives is determined so that in the final negative the contour will fall on the image of the known brightness and define all areas of that brightness within the scene.

It should be emphasized that the precision of the process depends not on readings of density, but on establishing contours which fall at known values. The density readings serve only as guides in the reprinting process.

For careful work where the entire field of the camera is used, as in studying the daylighting of a room, a correcting filter may be needed, as most lenses, even excellent ones, will not expose the entire area of film uniformly. Also, where the camera must be refocused between the scene and the calibrating exposure, the effect of this change of focus on the relative aperture must be considered.

The accuracy of this process, demonstrated in Fig. 3, depends on the relative uniformity of coverage of the lens, on the duplication of conditions affecting the photographs of the scene and those of the known brightness, on the precision with which the contour falls at the image of the known brightness and on the exactness with which this known brightness was measured.

Because this method measures brightness directly, specularly reflecting surfaces as seen from the position of the camera may be recorded and errors arising from instrument measurements and reflectance computations on surfaces which are not perfectly diffuse are removed.

This technique was developed for use in daylighting studies where it is necessary to make simultaneous measurements over a large area and through a wide range of values while conditions are changing rapidly. With a specially adapted camera, a range of 1-3000 footlamberts was recorded with one-half second exposure and with little more than the usual photographer's equipment needed at the scene. To obtain this range, a three-plate camera, intended for color separation work, was fitted with neutral density filters to provide three ranges of exposure.

Since the contours give a complete record for their value, overlooking no points in a complicated scene, since small areas may be enlarged and studied, and since slight variations as well as large ranges in brightness may be found, detailed studies may be made of such subjects as glass blocks and prismatic lenses.

The camera is also useful where the presence of

[1] Marsh, Charles: "Some Photographic Methods Applied to Photometry," ILLUMINATING ENGINEERING, Vol. XLVII, No. 10, p. 571 (October 1952).

A paper presented at the National Technical Conference of the Illuminating Engineering Society, September 9-13, 1957, Atlanta, Ga. AUTHORS: Pennsylvania State University, University Park, Pa. Sponsored by the Pittsburgh Plate Glass Co.

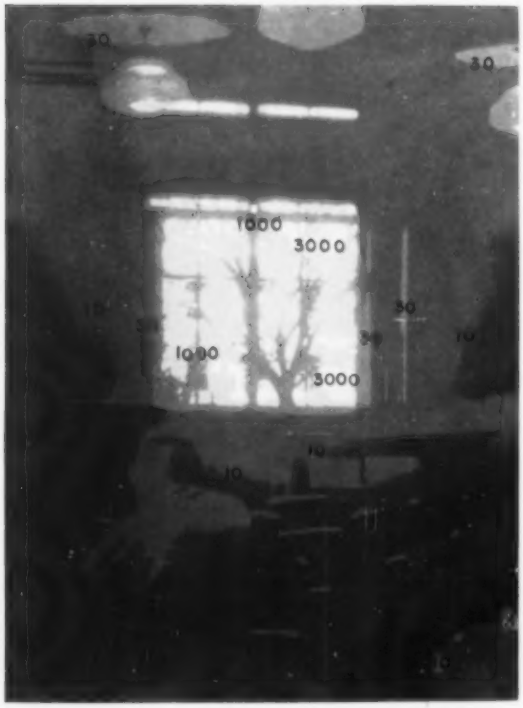


Figure 1

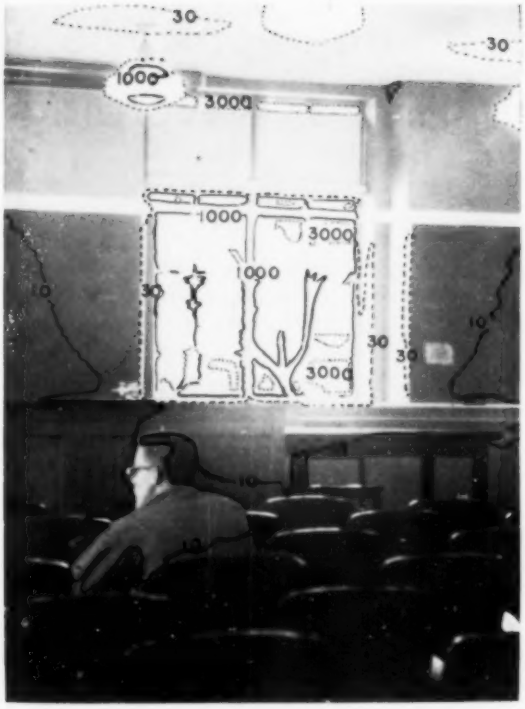


Figure 2

the instrument is a problem as in the study of models.

A range of brightnesses from more than 3000 footlamberts down to 3 is found in the classroom shown in Fig. 1. These brightnesses are recorded as contours of equal brightness at the boundaries between the shades of grey. Each shade of grey indicates an area whose brightness is between the values of the contours bounding it.

Thus, in the scene outside the window, the pale grey area is between 1000 and 3000 footlamberts. The boundaries between the palest and the next darker shade of grey are known to be at 1000 footlamberts, while the boundaries of the white areas are known to be at 3000 and those areas themselves are above 3000.

The lamp is known to be an object in sharp contrast with its background, hence the 30 footlambert contour at the lamp tells us only that the brightness is greater than 30. The significant information about the lamp comes from the 1000 footlambert contour which tells every point at that value.

Since not only the brightness, but also the size and position of bright areas are shown, the visual comfort of a room may be readily imagined, as in this glaring example of poor window placement.

In Fig. 2, the contours were sketched on a print from the original negative which recorded the lower brightnesses in Fig. 1. This rendition may be easier to understand, although it is not as exact as the previous print which was made by superimposing contours which had been derived from the original negative.

This record was made with a half-second exposure, using a triple plate camera in which three plates of different ranges were exposed at once.

For Fig. 3, the beam pattern of a spotlight was measured both with photographic contours and by scanning with a brightness meter for values of 4000 (open circles) and 400 (closed circles) footlamberts, to show correlation between the methods.

Minute variations in brightness are shown in Fig. 4, a study of pencil marks. A difficult seeing situation was arranged by illuminating the marks of a No. 2½ pencil, on manila paper, with a single light source so that specular reflection from the pencil marks reached the camera. Contours recorded here are 14 where highlights were reflected from the pencil marks, 12 over most of the paper, 10, and 8.

Appendix

The original exposures may be made on any type B, panchromatic film. One exposure will give a useful record of a ratio of brightness of 1:50. D:11 Developer, 1:1 strength, used for 8 minutes at 20°C

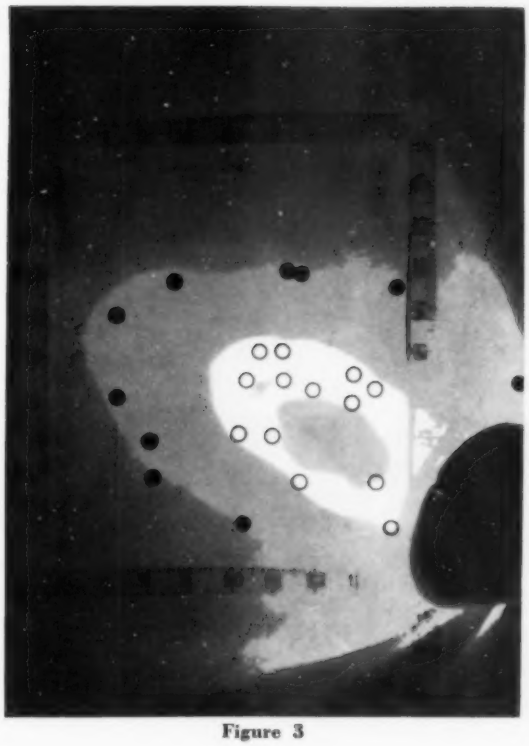


Figure 3

will give suitable contrast. The calibration exposures should be made on the same batch of film and given simultaneous development with the photographs of the scene.

Before preparing the negatives of the contours, a *H* and *D* curve may be drawn to show the gamma or contrast for the original film, by plotting optical density against the log of the exposure for the areas of known brightness. From this the densities recorded by other brightnesses may be found.

Very high contrast films such as Kodalith, developed in Kodalith developer as directed, are required for the high contrast negatives. This film is exposed in contact with the original film.

The time of exposure for this contact print depends on the density of the original negative at the image of the brightness to be recorded. To determine this time of exposure, make test exposures through a film having various densities for a wide range of times and plot the time each density on the negative must be exposed to register a density of 1.8 on the high contrast film.

This first contact print provides a fairly accurate positive. Repeat the process to make fine adjustments in calibration and to produce a negative. If the calibration is right, the image of known brightness will be neither black nor white, but grey or speckled, as the contour falls on it.

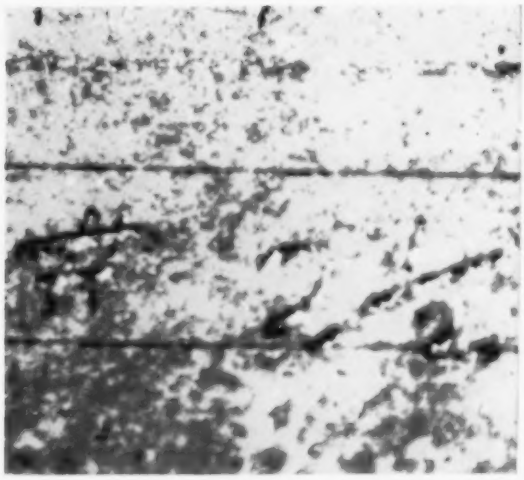


Figure 4

DISCUSSION

D. E. SPENCER:* The photographic procedures developed by the Marshes are interesting and should be valuable in many situations. One can immediately visualize an application in the examination of any luminous environment to see whether the 3:1 adaptation criterion is satisfied. If boundaries can be set for the brightness of the work, and for regions three times and one-third as bright, examination of a single photograph can immediately tell whether this criterion is satisfied or what parts of the field of view require modification. The analysis of specular reflections and the accompanying reduction of contrast are another important application.

A question for the Marshes — can they devise a photographic method for obtaining an accurate value of "adaptation brightness" in those situations in which calculations become unwieldy?

E. A. LINSDAY:** This paper presents a very interesting method of brightness measurement. Several points might be explained in more detail in order to extend its use.

Correcting the negative for non-uniform exposure due to camera limitations must be done in the camera if the full range of sensitivity of the film is to be used.

Further emphasis on the need for a standard brightness in each exposure would be desirable. This insures identical processing of the standard and the test areas. Also stray light from lens flare, etc., will have the same effect on the standard as on the rest of the field.

Caution should be suggested when comparing different colors or different light sources due to the difference between film response and average eye response to color.

It might be noted that lens flare diffusion in masks, etc., tends to give a slight overall exposure even in the dark areas of the scene. For accurate results would it be possible to reduce all brightnesses by this constant value?

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*University of Connecticut, Storrs, Conn.
**General Electric Co., Cleveland, Ohio.

713 Attend First Five

MMILJ Regional Contests

It might be said that each I.E.S. Regional Conference has a flavor all its own, the Guide format notwithstanding. Even in a report covering five of the conferences all at once, is this apparent. Emphasis is directed toward different aspects of the program, in different parts of the country, but one common denominator emerges — dedicated committees, everywhere. Earnestness and enthusiasm "beyond the call of duty" has led each of these meetings to its own special success.

Two highlights which are shared by all Regionals are the contest for My Most Interesting Lighting Job and a social occasion honoring the National President. A picture story of these two popular features, as conducted by the different Regions, begins this report on the first five Regionals.

SOUTHWESTERN. Contestants in Class I (photo above) were: Bill Irving, proxy for Marguerite Borelli, Central Oklahoma Chapter, first prize; Ruth Patterson, proxy for Lucille Payne, North Texas Section; Roger Gardner, Ark-La-Tex Chapter. Class II contestants (photo at left) were: J. G. Harriss, Jr., Ark-La-Tex Chapter; Floyd A. Covington, Alamo Section; L. Hamilton, North Texas Section, first prize; T. L. Lynn, proxy for Keith E. Taylor, Panhandle Chapter.

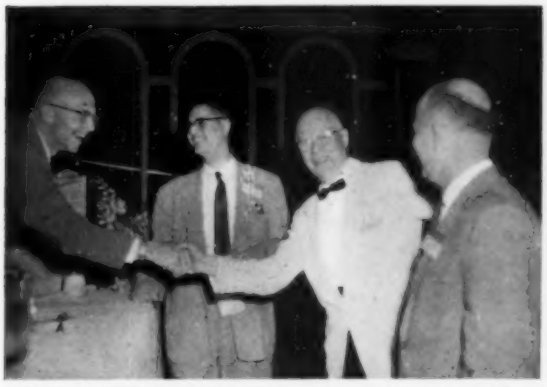
EAST CENTRAL. At Richmond the entries in the contest were presented by: B. J. Goodman, Capitol Section; C. L. Taylor, Virginia Section; G. W. Wagner, Philadelphia Section, winner in Class II; Elizabeth Meehan, Philadelphia Section, winner in Class I; E. F. Siegel, Maryland Section; Donald Thomas and Howard Gamble, Class II and I respectively in the Pittsburgh Section's MMILJ Contest.

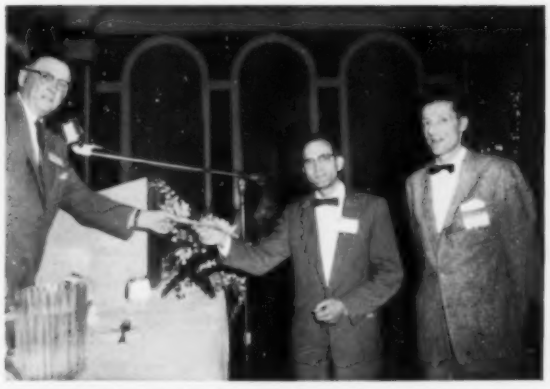
I.E.S. Regional Conferences

. . . Toronto's contest should be immense. So far every Section and Chapter has sent a representative to its Regional contest. All contestants shown on these two pages won First Prize in their local contest; some won First at the Regional.

TYPICAL of the high caliber of judges at the Regional MMILJ contests are those who served at the Midwestern conference (right). Left to right, J. Carl Wilson, Canadian Regional V-P; R. G. Slauer, General Secretary; G. J. Taylor, First Vice-President. MMILJ Chairman Don Ingwerson is at right.

MIDWESTERN. Class I winner, William Kuhnke, Milwaukee Section receives check from President Reid, in photo at left. Also headed for Toronto is Class II winner Melvin Cohen, Chicago Section, in photo at right.





SOUTHEASTERN. James A. Banton, Regional V-P shakes hands with Robert Kuzell, Georgia Section, first in Class I, as R. E. Faucett, Palmetto, and Coy C. Jordan (far right), Tar Heel Section, winners in Class II, look on.

SOUTH CENTRAL. George Morris, Regional V-P hands certificates and checks to first prize winners, James Fletcher, Mid-South Chapter, Class II; and George Schroeder, New Orleans Section, Class I.

President and Mrs. Reid were honored with Receptions, Banquets and gifts from the Regions at . . .

NORTHEASTERN Regional Conference, Hartford, Conn. (shown with Ed Cole at Reception).

EAST CENTRAL Regional Conference, Richmond, Va. Williamsburg plates to Mrs. Reid.

SOUTHWESTERN Region, Shreveport, La. Mrs. Reid beams with antique silver teapot.

SOUTH CENTRAL and SOUTHEASTERN Regional, Little Rock, Ark. Chairman John Williams presents a silver tray as gift from the two Regions.

MIDWESTERN Regional, Kansas City, Mo. At Reception, the Reids (left) pose with next year's Presidential couple, Mr. and Mrs. George J. Taylor (center) and Ruby Redford, I.E. Editor (right).

Northeastern Regional Conference

Date: April 10-11, 1958
Place: Statler Hotel, Hartford, Conn.
Attendance: 75

Emphasis at this meeting was definitely on the technical program. In this direction it could serve as a pattern of what-to-do for the desired technical sessions. It came as close as any ever will to the ideal expressed for a regional conference program — pitched close to the level of a national conference; slanted to a group of practitioners.

Further, it served to bring the Society's work to the attention of the public at large. This latter was largely through the work of Dick Ballard, Publicity Chairman for the Connecticut Section. His approach was for *public relations* in the best sense, with television coverage of the technical sessions, televised interviews with President Reid, and newspaper releases on pertinent phases of the Regional program. It would be difficult to measure the advances made by I.E.S. (and by the good lighting philosophy) in this area, but they must be considerable, with so adult an approach to good public relations.

In any case, the predominant "flavor" for this conference was a feeling of "eager young Chapters side by side with experienced old hands."

This combination paid off for the delegates in an exceptionally "meaty" program. Pencils were whipped out often at Hartford, for take-home notes. It would be hard to say which session inspired the most note-taking, but undoubtedly the discussion most eagerly awaited was that of C. L. (Cash) Crouch's outline of the new basis for footcandle recommendations. This description of the Blackwell researches (see I.E., April 1958, p. 9A), with a glimpse at possible future recommended illumination levels, is scheduled for each of the nine Regional Conferences to be held this year. Quite naturally, there is great eagerness for details of the eight-year research which has established a valid basis for determining required illumination levels for given visual tasks.

Some indication was given in Mr. Crouch's discussion as to the magnitude of levels which may be in order for such tasks as school work, sewing, reading and for industrial tasks. Notes were made, to be sure. Actually, so timely was this subject, in Hartford, in April, that new levels recommended by the various I.E.S. technical committees had not yet been studied by Council nor officially approved. Some of them are still in committee. First availability of all of the new recommended levels will be the new *IES Lighting Handbook* now in production. Mr. Crouch's preview, however, and his lucid outline of the research technique, which led to a scientific basis for making recommendations, was a high spot — at all of the Regional Conferences.

Perhaps of equal significance was a report given at Hartford by John Chorlton, Chairman of the School Lighting Committee. This dealt with a six-year study of a special task committee manned by members of I.E.S., A.I.A., and the National Society for Schoolhouse Construction. Their work has culminated in a sound approach to school lighting recommendations, Mr. Chorlton said, which will be reflected in the forthcoming revised Recommended Practice for School Lighting. He predicted the proposed new Practice would be presented to Council in August of this year.

Setting the pace at Hartford, C. L. Crouch spoke at every Regional Conference this year, outlining the new basis for footcandle recommendations.

Panels are ever of interest to conference delegates; certainly the five-man panel presented at Hartford was. A hypothetical office building was discussed, baring the problems encountered by architect, consulting engineer, contractor, lighting engineer and maintenance expert. Audience participation was brisk.

Hartford was a natural, of course, for a session on street lighting. This "cradle of street lighting progress" is known nation-wide for its constructive attack on night driving hazards.

Five other sessions completed the conference, these likewise of timely interest. The residential lighting discussion by Myrtle Fahsbender disclosed new techniques and equipment in this field. Light for Plant Growth was discussed by one of the world's few experts on this subject, J. P. Ditchman of Nela Park. Maintenance Factors, by Willard Allphin and John Neidhart evoked a discussion which

Registering the delegates, H. R. Young (seated), and Francis Clark, Connecticut Section.

Residence lighting, an old friend finding an upsurge in interest, demonstrated by Myrtle Fahsbender.

Exemplifying high level of technical program was this "information panel," discussing problems encountered in office buildings. With Jack Hamilton (rostrum) as Moderator are: D. E. Smith, President A.I.A. Connecticut Chapter; J. L. Ottenheimer, Consulting Engineer; Ed Cole, representing utility viewpoint; J. T. Dolan, President N.E.C.A., Connecticut Chapter; Francis Clark, National Association Lighting Maintenance Contractors.

threw the schedule way off, and application possibilities of the new high-output lamps by Russell Churchill met with avid interest.

In the Northeastern Region, four contestants sought the MMILJ prize in the Commercial Division, three for the best Residential entry. The results:

Class I (Residential)

First Prize — Sylvan R. Shemitz, Connecticut Section

Second — John C. Gould, Eastern New York Section

Third — Roger B. Cole, Jr., New York Section.

Class II (Commercial)

First Prize—Noel S. Florence, New York Section

Second — Tied between Harold R. Young, Connecticut Section, and Bart Barney, Yankee Chapter

Third — Warren W. Reeves, New England Section.

Judges for the contest were: Class I, Myrtle Fahsbender, Clifford Forrester, Ruby Redford. For Class II, C. W. McCormick, John Neidhart, Ed Waldron.

Although the Northeastern Region featured no "ladies program" as such (and only four visiting ladies were present), nevertheless the conference wasn't *all technical*. A banquet and dance Thursday evening honored President and Mrs. Reid; an especially brilliant social event, as a matter of fact. Conference Chairman Robert Chase, Connecticut Section, presented a gift to Mr. and Mrs. Reid, on behalf of the Region. A product of the Region itself—beautiful Kensington ware bowl and sandwich plate—the gifts were engraved with I.E.S. emblem, name, date and occasion, to serve as a permanent memento of this successful conference.

Also for permanent record, the complete technical program and committee personnel are listed below:

Morning Session, April 10

Moderator — John H. French, Chairman, Yankee Chapter.

Opening Remarks — C. E. Waldron, Vice-President, Northeastern Region; Robert Chase, Conference Chairman; Robert Babcock, Chairman, Connecticut Section.

Welcome to Connecticut — John Dempsey, Executive Assistant to the Governor of Connecticut.

Address by Kirk Reid, National President, I.E.S.

Highway Lighting — Dana Rowten, Westinghouse Electric Corp.

Report on New Footcandle Recommendations—Cash Crouch, Technical Director, I.E.S.

Afternoon Session, April 10

Moderator — Herbert A. Anderson, Chairman, New York Section.

Residential Lighting, Miss Myrtle Fahsbender, Westinghouse Electric Corp.

Panel Discussion — "My Problems in Lighting a New Office Building"

Architect — Dwight E. Smith, President, Connecticut Chapter, A.I.A.

Consulting Engineer — Joseph L. Ottenheimer, Albany, N. Y.

Electrical Contractor—John T. Dolan, President, Central Connecticut Chapter, National Electrical Contractors Association.

Utility Representative — Edward R. Cole, Hartford Electric Light Co.

Lighting Maintenance — Francis Clark, Charter Member, National Association of Lighting Maintenance Contractors.

Another greatly significant study reported was school task measurements by John Chorlton, right, shown with session chairman Walter Ball.

Public relations — thousands of viewers in New England area heard I.E.S. aims described by President Reid in this interview on WNBC-TV, Hartford.

Morning Session, April 11

Moderator — W. L. Ball, Chairman, New England Section.
New Higher Output Sources—Russell Churchill, General Electric Co., Nela Park.
Report on Proposed New School Lighting Practice — John Chorlton, Toronto Board of Education.

Afternoon Session, April 11

Moderator — J. R. Hartman, Chairman, Eastern New York Section.
Maintenance Factors — Willard Allphin, Sylvania Electric Products Co.; John Neidhart, The Miller Co.
"My Most Interesting Lighting Job" Competition — Robert Babcock, Chairman.
Light for Plant Growth — Joseph Ditchman, General Electric Co., Nela Park.

CONFERENCE PERSONNEL

C. E. Waldron.....V-P, Northeastern Region
R. D. Babcock.....Chmn, Connecticut Section
J. R. Hartman.....Chmn, East. New York Section
W. L. Ball.....Chmn, New England Section
H. A. Anderson.....Chmn, New York Section
John French.....Chmn, Yankee Chapter
Robert Chase.....Conference Chairman

SUBCOMMITTEE CHAIRMEN

R. E. Ballard.....Publicity
E. R. Cole.....Entertainment
H. R. Young.....Finance
L. A. Senofonte.....Registration and Reception
C. Harper, B. J. Teraila.....Properties
T. Ake.....Papers and Program

"Togetherness." Eager young Chapters and experienced old Sections teamed up for the success of the Northeastern Regional Conference, Hartford, Conn., April 10-11. Section/Chapter Chairmen shown l. to r. front row: John H. French, Yankee; R. D. Babcock, Connecticut; J. R. Hartman, Eastern New York; C. E. Waldron, Reg. V-P; Robert Chase, Conference Chairman. Back row: Jack Hamilton, incoming New York Section Chairman; Walter Ball, New England; John Carr, Secretary, New England; missing from picture H. A. Anderson, present Chairman of the New York Section.

East Central Regional Conference

Date: April 14-15, 1958
Place: John Marshall Hotel
Richmond, Va.
Attendance: 150

This conference had *three* "flavors." Actually, in fact, its program was in three separate parts, with even a change of site. Part I, April 14, opened traditionally enough, at the John Marshall Hotel in Richmond. This consisted of three technical sessions (Monday morning and afternoon and Tuesday morning), each especially well planned to bring up-to-date information to Conference delegates.

In common with other conferences, Part I started with a warm address of welcome from the Attorney General of Virginia, Albertis S. Harrison, and proceeded with papers pertinent to engineers as of Spring 1958.

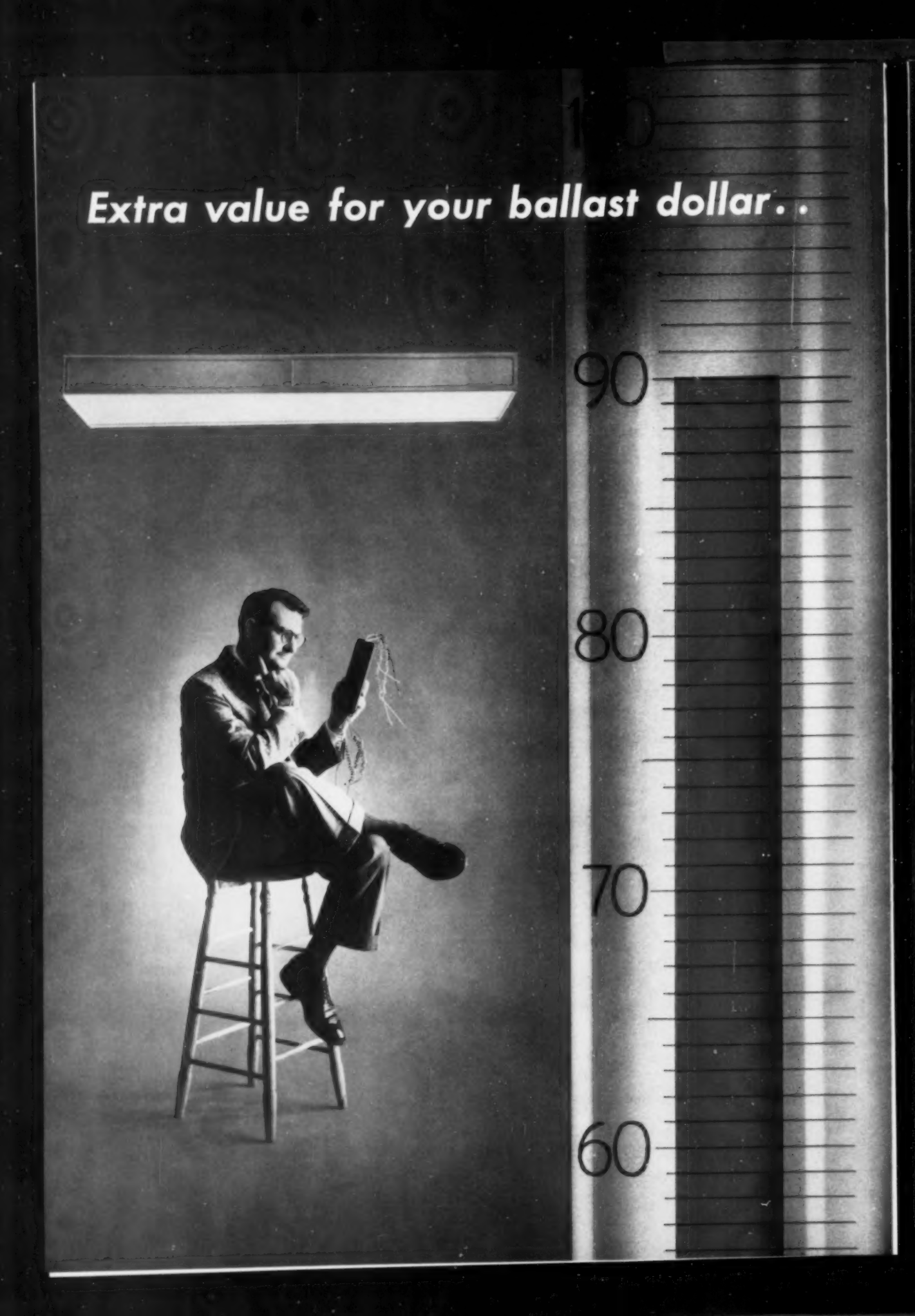
Part II moved the entire conference to Williamsburg, 50 miles away. This might be termed the "Historical" session. Although this did include an extremely enjoyable tour of this remarkable restoration of colonial America, it was nevertheless a distinct part of the technical program also. Following the tour, the entire group of 150, including the ladies, met at the Williamsburg Theatre. Here two interesting papers were presented, covering the lighting and architectural design of the new Information Center recently built on the outskirts of the old city. These were presented by A. Edwin Kendrew, Senior Vice-President and Director of Architecture for Colonial Williamsburg; and Gerald B. Ewing, Lighting Designer. Included in this phase of the program also was a special showing to I.E.S. of the color film "Story of a Patriot" depicting events leading to Virginia's participation in the American Revolution.

The temptation was irresistable to many IES'ers to overlap this phase of the program with Part III, Social. Many eschewed the returning bus, and stayed on in Williamsburg for another day.

The social phase of East Central's conference was itself in several parts. Some

(Continued on page 17A)

Leaders at the 1958 Richmond Conference — President K. M. Reid, C. C. Shotwell (speaking), Regional V-P, and J. S. Ragland, Conference Chairman.


Extra value for your ballast dollar..
90
80
70
60

New G-E Ballast operates at less than 90C*

Announcing the new General Electric 6G1020 ballast for two 40 watt T12 rapid start lamps, the first in a line of ballasts that meet the demands of lighting progress.

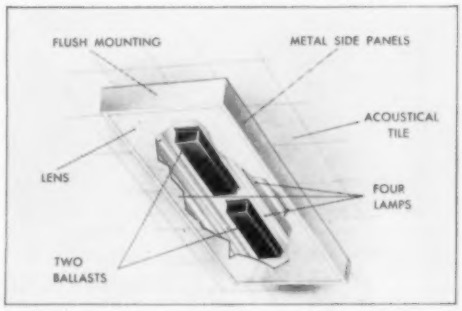
Now, with no sacrifice in light output, sound rating, size or weight, General Electric offers you a ballast that, under normal ambient conditions, will operate below 90 C on the hot spot in any modern surface mounted totally enclosed four-lamp fixture.

There's a lot of talk in the lighting industry about the problem of ballast heating. The problem has existed since the first ballast was energized and will exist as long as there is progress in architectural, fixture and lamp design.

Actually, today's standard tests do not adequately cover ballast heating. Ballast heat tests originally developed as representative of earlier lighting installations do not give a true indication or measurement of how the ballast will operate in today's modern installations. The demand for higher working foot-candles and more efficient, more eye-appealing factories, offices and homes is being met through the introduction of higher output lamps, modern fixtures and the utilization of modern design concepts such as lower ceilings and sound-absorbing materials. True, the demands are being met, but this lighting progress also has generated new heat problems for the ballast industry to solve.

The most important step in solving this problem has been the development of a realistic new approach and new facilities for accurately determining ballast operating temperatures. General Electric ballasts are now tested in a new ballast-fixture heat test room. In this way,

*at room ambient of 25 C



Modern enclosed fixtures have increased light output but at the same time have contributed to today's ballast heating problem.

General Electric ballast heat measurements reflect actual operating conditions.

Each fluorescent lighting application is accepted as a separate challenge by General Electric engineers who know there is no one ballast that will act as a solution for all heating problems.

If fluorescent lighting progress is to continue, new low temperature ballasts must be developed. General Electric will continue to be a leader in ballast progress . . . another example of General Electric's OPERATION UP-TURN...extra value for your ballast dollar. Section 401-68, General Electric Company, Schenectady 5, N. Y.

OPERATION up turn
Buy now for extra values
GENERAL ELECTRIC

GENERAL ELECTRIC

Q. *High Cost, "Special" Lighting Job?*
A. *No, Fixtures are Standard* – **by Litecontrol**

This adroitly planned and handsomely furnished (and illuminated) interior is the main banking floor of the Society for Savings, West Hartford, Connecticut. There is a note of restful charm to the room yet the premises are entirely functional and business-like.

Embedded in acoustic plaster, Litecontrol 6000 Series equipment, with Plexiglas dish diffusers provides the basic lighting (the cone shaped fixtures were supplied by others). The perfectly straight rows of fixtures illuminate without even a suggestion of glare — perfect to work *under* and *by*. A trigger catch on a removable hinged door provides easy access for servicing.

Like all good installations, this was a "team job" of architect, engineer, electrical contractor, client and ourselves. If *you* are looking for a lighting equipment manufacturer for *your* "team" who can help produce results like this *at sensible cost* — look to Litecontrol.

INSTALLATION:
Society for Savings, West Hartford, Connecticut
ARCHITECT:
Jeter & Cook, Hartford, Connecticut
ENGINEER:
Henri van Zelm Associates — Designed by Walter Heywood
ELECTRICAL CONTRACTOR:
The Preston Electric Co., West Hartford, Connecticut
FIXTURES:
Litecontrol No. 6044-RS 4 lamp recessed 2' x 4' fixtures with translucent Plexiglas dish. F40T12/CW/RS 40 watt Standard Cool White Rapid Start lamps.
CEILING HEIGHT:
12' — 0"
INTENSITY:
Average 110 foot-candles in service.

LITECONTROL
Fixtures
KEEP UPKEEP DOWN
LITECONTROL CORPORATION,
36 Pleasant Street, Watertown 72, Massachusetts

DESIGNERS, ENGINEERS AND MANUFACTURERS OF FLUORESCENT LIGHTING EQUIPMENT DISTRIBUTED ONLY THROUGH ACCREDITED WHOLESALERS

When the Virginia Section was once before host to I.E.S. — twenty-eight years ago. The handsome young couple seated left at the center front table were, at the 1958 Regional Conference in Richmond, the guests of honor — President and Mrs. Kirk M. Reid. Another item distinguishing this picture — it was the first Convention photo taken with flashlamps. Attendance at this 1930 national Conference banquet was 476.

(*Continued from page* 13A)

55 ladies attended this meeting, for one thing. So active was their program, they could easily confuse it with a full-scale convention, well planned, in a resort area. Chairmanned by Mrs. C. E. Anderson, this program combined leisurely Southern charm with a whirlwind good time.

It started out even before the Conference, with a party Sunday evening, in which the whole conference joined. From there it whirled on to brunch together every morning, a bus tour of Richmond, lunch and fashion show. This was only the beginning. Before joining the men in Williamsburg, the 55 ladies left in their own bus early Tuesday morning and toured the historic Virginia countryside on the way. Noon-day stop was at "Berkeley," a James River plantation of surpassing beauty. Built originally in 1726 by Benjamin Harrison, this early Georgian mansion is in its original stately condition, and, indeed, is occupied by its owners, who open their doors to the public several times a week. The IES women inspected every nook of it, together with its lovely English colonial furnishings.

The broad lawns of Berkeley, sloping down to the river, were the site this day for the IES feminine visitors' box picnic luncheon. The Ladies Committee had supplied southern fried chicken, hot ham-biscuits and other delicacies all done up in picnic boxes; hot coffee by the gallon separate. This was enjoyed on the warm grass, early-comers getting the shadiest trees with the most peach blossoms.

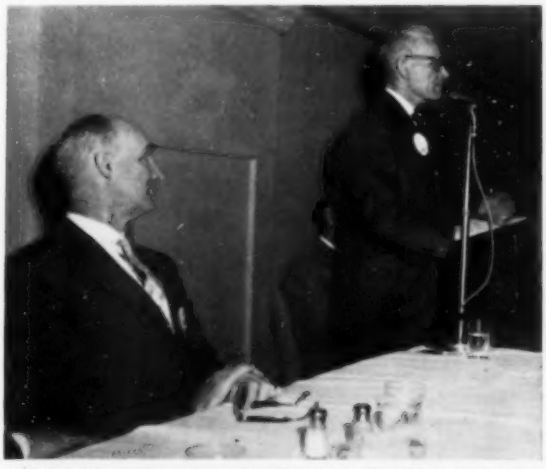
After lunch, on again to Williamsburg, and their own separate tour of the Restoration. The main conference was joined at the Information Center, for the film and additional papers.

Highlight of Part III, Social, included all in attendance. This was the dinner-dance Monday evening, honoring President and Mrs. Reid. It rivaled the last large dinner-dance held by IES in Richmond — back in 1930, when the Virginia Section was host to the national convention (see cut). Guest speaker at dinner, L. L. Ray, North Carolina State College, combined serious comment with hilarious discourse, and interfered not at all with the merriment.

Guests of Honor, President and Mrs. Reid received, as a souvenir of the occa-

(*Continued on page* 18A)

One hundred and fifty were registered at the East Central Regional Conference in Richmond, April 14-15, 1958. Here, signing up a delegate to the Conference is R. T. McCrone, at the registration desk.



Before he returned to Cleveland in late May, President Reid addressed approximately 2000 I.E.S. members — more than twice the number at a national Conference. This picture, a luncheon meeting in Richmond.

Caliber of speakers was high. In photo at left, with session chairman H. M. White, Maryland Section, is (right) R. D. Churchill, General Electric light source specialist.

In one of the other sessions, photo at right, R. R. Wylie. Sylvania; J. S. Ragland, Charles S. Leopold, and session chairman S. W. Charlesworth, Capital Section.

(*Continued from page* 17A)

sion and gift from the Region, a set of Williamsburg plates and a beautiful brass colonial trivet.

The Region's MMILJ contest should not (in fact *could* not) be overshadowed by so successful a social program. This was held Monday afternoon, with four competing for prizes in the Commercial Division, and four for Residential. The winners:

Class I

First — Elizabeth Meehan, Philadelphia Section

Second — Howard Gamble, Pittsburgh Section

Third — C. L. Taylor, Virginia Section

Class II

First — G. William Wagner, Philadelphia Section

Second — Donald Thomas and Dan Schmidt, Pittsburgh Section

Third — B. J. Goodman and Albert A. Fox, Capital Section.

Judges:

Class I — E. W. Kelsey, E. W. Beggs, Ruby Redford

Class II — R. R. Wylie, C. L. Crouch, R. D. Churchill.

Address Changes should be reported to I.E.S. Headquarters by the first of any month, to insure the uninterrupted mailing of I.E. and other Society communications.

Program and committee personnel responsible for this Conference follow:

Sunday Evening, April 13

Meeting Local Activities Committee, Washington Room.

Monday Morning, April 14

Opening Ceremonies — Marshall Room.
Conference called to order — J. S. Ragland, General Chairman of Conference.
Virginia Welcome — Hon. Albertis S. Harrison, Jr., Attorney General of Virginia.
Region Welcome — C. C. Shotwell, Vice-President, East Central Region.
First Technical Session, Chairman, S. W. Charlesworth, Chairman, Capital Section.
The Effect of Lighting Methods on Air Conditioning Design—Charles S. Leopold, Charles S. Leopold Engineers.
Stop! And Buy It Here — R. R. Wylie. Sylvania Electric Products Inc.

Monday Afternoon, April 14

President's Luncheon, Jackson Room, Presiding, E. W. Kelsey, Chairman, Eastern Pennsylvania Section.
Address by Kirk M. Reid, President I.E.S.
Second Technical Session, Chairman, P. K. Allen, Chairman, Maryland Section.
Design and Application of Higher Output Fluorescent Lamps — R. D. Churchill, General Electric Co.
Regional Competitors, My Most Interesting Lighting Job.

Monday Evening, April 14

President's Dinner-Dance.
Master of Ceremonies, J. S. Ragland, Chairman. Virginia Section.
Speaker, L. L. Ray, Assistant to the Chancellor, North Carolina State College.
Presentation of MMILJ Awards.

Tuesday Morning, April 15

Third Technical Session, Chairman, R. R. Enghouser, Chairman, Philadelphia Section.
New Developments in Mercury Lamps and Lighting—E. W. Beggs, Westinghouse Electric Corp.
Lighting for Color Appraisal in Graphic Arts — A. E. Sterner, Jr., Allen, Lane & Scott.
Put the Right Ballast Before the Lamp — M. E. Robertson, Jefferson Electric Co.
Closing Remarks for Richmond Sessions. Instructions for Williamsburg Trip.

Tuesday Afternoon, April 15

Progress Luncheon, Presiding, J. A. Hodges, Chairman, Pittsburgh Section.
The Eyes Have It — C. L. Crouch, Technical Director, I.E.S.
Fourth Technical Session — Williamsburg Trip. Chairman, W. G. Cornelius, Virginia Section.
Tour of Williamsburg.
The Architectural Design of the Information Center Building — A. Edwin Kendrew, Senior Vice-President, Director of Architecture, Construction and Maintenance, Colonial Williamsburg.
The Story of a Patriot — film.
The Lighting Design of Colonial Williamsburg Information Center — Gerald B. Ewing, Lighting Designer.

EXECUTIVE COMMITTEE

C. C. Shotwell.....*Regional Vice-President*
J. S. Ragland.....*Conference Chairman*
L. W. Ferguson.....*Vice-Chairman*
D. N. Jenks.....*Past Chairman, Virginia Section*
E. H. Powell.....*Secretary-Treasurer*

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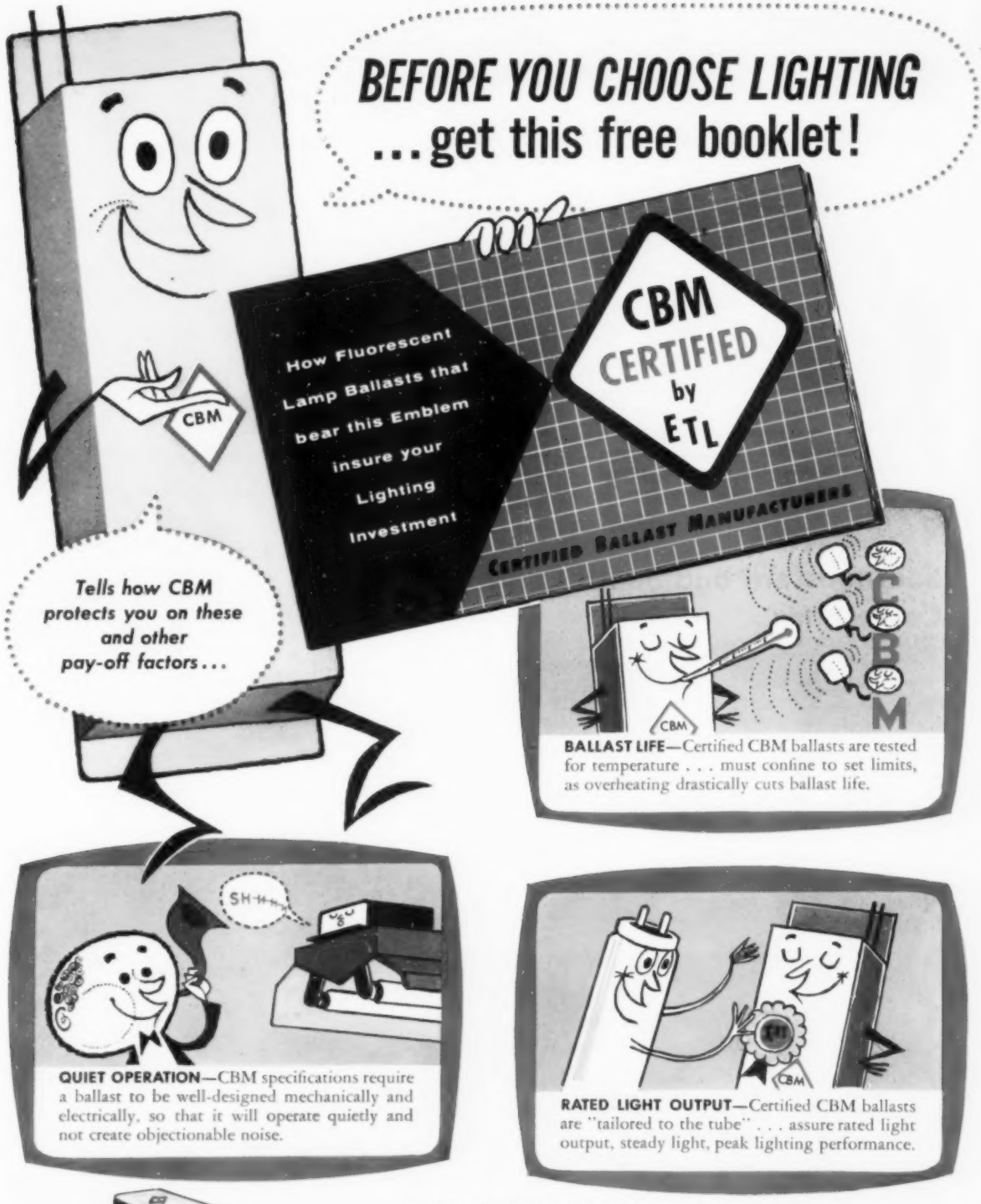
E. F. Bailer — Secretary, Capital Section
E. W. Kelsey — Chairman, Eastern Pennsylvania Section
J. R. Fritz — Secretary, Eastern Pennsylvania Section
P. K. Allen — Chairman, Maryland Section
J. D. Smith — Secretary, Maryland Section
R. R. Enghouser — Chairman, Philadelphia Section
W. P. Graham — Secretary, Philadelphia Section
J. A. Hodges — Chairman, Pittsburgh Section
W. A. Eisenhauer — Secretary, Pittsburgh Section
J. S. Ragland — Chairman, Virginia Section
W. G. Cornelius — Secretary, Virginia Section
Ladies Committee — Mrs. C. E. Anderson
Finance Committee — E. H. Powell
Papers and Program Committee — W. G. Cornelius
Attendance and Publicity Committee — H. B. Turner
Registration, Reception and Hotel Committee — R. T. McCrone
Lighting Display and Decorations Committee — R. B. Buchanan
Transportation Committee — R. W. Thomas
Entertainment Committee — J. C. Downing.

(*News continued on page* 20A)

BEFORE YOU CHOOSE LIGHTING ...get this free booklet!


How Fluorescent Lamp Ballasts that bear this Emblem insure your Lighting Investment
CBM CERTIFIED by ETL
CERTIFIED BALLAST MANUFACTURERS
CBM
Tells how CBM protects you on these and other pay-off factors...
CBM
BALLAST LIFE—Certified CBM ballasts are tested for temperature . . . must confine to set limits, as overheating drastically cuts ballast life.
SH
QUIET OPERATION—CBM specifications require a ballast to be well-designed mechanically and electrically, so that it will operate quietly and not create objectionable noise.
RATED LIGHT OUTPUT—Certified CBM ballasts are "tailored to the tube" . . . assure rated light output, steady light, peak lighting performance.
CBM CERTIFIED by ETL

Send for this free booklet and learn how these factors and 11 others help insure your lighting investment when you buy fixtures equipped with Certified CBM ballasts.

Eight leading manufacturers now make up the association of

CERTIFIED BALLAST MANUFACTURERS

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Participation in CBM is open to any manufacturer who wishes to qualify

CBM-6-U

Regional and local membership statistics were the basis of Brooks Chassaing's interesting discussion. Mr. Chassaing, Director and national Membership Chairman, visited several of the Regional conferences.

Packed sessions attested to the interest in other lectures by l. to r.: R. G. Slauer, Sylvania Electric Products Inc.; shown with J. S. Williams, General Chairman; Bob Pilcher, Arkansas Chapter Chairman; and W. J. Fitzgerald, Koppers (Plastics) Co. Mr. Slauer and Mr. Fitzgerald spoke at the Thursday morning session.

Southeastern and South Central Regional Conference

Date: April 24-25, 1958
Place: Lafayette Hotel
Little Rock, Ark.
Attendance: 118

Success of the Regional Conference at Little Rock this year can be measured in inverse ratio as a square of the number of Regions sponsoring it. Under John S. Williams as General Chairman, the Conference was sponsored jointly by the Southeastern Region and the South Central Region of I.E.S.

Welcome to attendees, in fact, started on the sidewalk under the hotel marquee. Delegates stepping from cabs and buses were greeted even before their bags were unloaded, by both Regional Vice-Presidents, a past V.P., Conference Chairman, and host Chapter Chairman, a gracious gesture which turned out to be typical of the interest and welcome felt throughout the conference.

The address of welcome, opening session, was more apropos to I.E.S. than any one had a right to hope; the papers presented stirred up more questions and from the floor discussions than any conference so far observed; parallel sessions were required to accommodate the comprehensive program; even the MMIIJ contest had two first prize winners, both to represent the area in Toronto!

Key note speaker, W. M. Shepherd, V.P. of Arkansas Power and Light Co., called illuminating engineers, architects and consulting engineers the PhD's of their fields, for which reason he urged that they take the lead in innovations, even unpopular ones. His constructive talk provided a most appropriate note to the papers which were to follow. These did, indeed, suggest innovations — in concept (examples: presentations by C. L. Crouch, R. G. Slauer, George Gilleard and President Kirk M. Reid); in materials (per W. J. Fitzgerald, R. D. Churchill); and in their application — by Edward Rambusch, H. G. Blum, Jan Reynolds, Eve Freyer, J. C. Yeager, and A. D. Harrington.

Mr. Crouch's presentation was, of course, one of ten such discussions featured at each of this year's regional conferences. Everywhere he speaks, members are eager to hear details of the new approach to footcandle recommendations. They are fortunate in Mr. Crouch's complete knowledge of every detail of the Blackwell researches which led to this new method of evaluating illumination needed, and his ability to explain the work simply and clearly.

R. G. Slauer's talk certainly met the advocation of leadership. He predicted a revolution in school lighting by 1959, after a six-year stand-still in this field,

(Continued on page 23A)

Parallel sessions were required for the technical program at Little Rock. In one session, Residential Lighting with Eve Freyer, Westinghouse, shown center rear demonstrating equipment trends after her lecture.

Wall-to-wall lighting with PARAGRID-TILE

A new and important tool in the hands of those who set new trends in illuminating engineering.

Paragrid-Tile is an entirely new concept of illuminated ceiling design, incorporating bi-planar louver construction.

Super-thin U-Trax longitudinal supports (only $\frac{3}{8}$" wide) provide minimum interference with efficiency and, combined with directional plastic ribs, give striking appearance.

U-Trax now available in Golden Finish, as well as Standard White.

Try unique Paragrid-Tile, with U-Trax, in one area . . . it will prove its appeal!

Write for descriptive folder

Installation of Paragrid-Tile in office of General Manager, Carling's Breweries Limited, Montreal, Quebec.

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J.A.WILSON LIGHTING & DISPLAY

U.S.A.: 516-17 G. Daniel Baldwin Building, Erie, Pa., Phone 21-1364
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How to get the right glass protection for your lighting

Take a look at the pictures on this page.

In each case you'll note that the problem was different. But the answer is *always* the same . . . glass by Corning.

There's good reason for this. From Corning you get the know-how and backlog of experience that means a *quick* solution for your problem. It's been that way since Corning developed lens designs to give increased candle power, light control and distinctive colors to make train operations faster and safer.

Drawing from a wide variety of glasses and forms, we may suggest *adapting* a standard product, like the PYREX brand tubing used in the tunnels. Or, we may start from scratch—design, develop and produce to fit *your* specs and budget.

Whatever the need—*protection*, *direction*, or *color correction*—nothing serves lighting like glass by Corning.

That's why so many people think of Corning when they think of glass. May we hear from you?

1. TRANSPARENT ARMOR—PYREX tubing is rugged stuff. It's physically strong, resists weathering and can be washed down with a hose. That's why 12 foot sections of this tubing are used to protect the fluorescent lamps pioneered in the Brooklyn Battery Tunnel and now widely used in this country and abroad for tunnel lighting.

2. PORTABLE POWER—Campers, world travelers and others away from the convenience of electrical outlets find this portable lantern to their liking. It provides 300 candle power and its mantle burns at 3,000° F. Its PYREX globe is easy to keep clean and resistant to sudden temperature changes.

3. NO DANGER—Sometimes you have to put a light in sensitive spots—as in chemical plants where a spark can cause a disastrous explosion. So you design an explosion-proof light and cover it with a specially strengthened globe, from Corning, of course.

4. SHOT PROOF—Cleaning castings with blasts of shot was raising havoc with light bulbs. At first the alternatives seemed to be either to work in the dark or to keep replacing bulbs. Final outcome: Corning devised a heavy-wall globe made from abrasion-resistant glass.

Corning means research in Glass

CORNING GLASS WORKS, 33-6 Crystal Street, Corning, N.Y.

And Jan Reynolds, Sylvania, speaking on color and light, also at the Residential session.

At parallel street lighting session, A. D. Harrington, J. M. Gensberger, Chairman, and Joseph C. Yeager.

(*Continued from page* 20A)

only, however, if lighting engineers properly interpret and succeed in the acceptance of the new (Blackwell) findings for required illumination levels. He felt these findings present an important challenge to lighting practitioners. To meet them, products must change, techniques must change — but most of all, there must be a change in almost all of our concepts of what is needed in schools. He termed 30 fc a need in schools, and the new levels in the neighborhood of 80 fc a "best." As an example of the educational and selling job ahead for lighting men, he estimated the extra 50 fc between *need* and *best*, would raise school building costs 50¢ to 75¢ per square foot and would add 2 kw to the heat load.

George Gilleard's presentation departed from format. Following a 20-minute "ground talk" on store lighting, he initiated a brain-storming session in which all participated. Far from the usual question and answer discussion, this stimuled innovations, to be sure. Ed Rambusch, of course, is ever a pleasure—education with a spice of humor. Three speakers were held overtime after the sessions, for further answers and crowd inspection of new equipments they had. These were Russ Churchill of GE, Jan Reynolds of Sylvania, and Eve Freyer of Westinghouse (see program).

Both Regions were represented in the MMILJ, with not a single Section or Chapter missing in either of them. This added up to six entries in Class I, Residential, eight in Class II, Commercial. This can safely be termed the largest Regional contest, quite likely; certainly it was a most interesting session, no pun intended. Results of the contest:

Southeastern Region

Class I: First place, Robert J. Kuzell, Georgia Section

Class II: First place, jointly won by Robert E. Faucett, Palmetto Section and Coy C. Jordan, Tar Heel Section.

South Central Region

Class I: First, George A. Schroeder, New Orleans Section
Second, Gene A. Bates, Alabama Section

Class II: First, James F. Fletcher, Mid-South Chapter
Second, H. S. Gregory, New Orleans Section
Third, Sam Davidson, Alabama Section

(*Continued on page* 27A)

Second session participants, Glenn McMullen, Chairman (Mid-South), George Gilleard, Russ Churchill, and Edward Rambusch.

G. W. Drane (Mississippi Chapter), Chairman, thanks H. G. Blum (right), speaker.

RIBBONS OF LIGHT—Sylvania recessed troffer lighting can be mounted in continuous rows and spaced for desired high lighting levels in modern business offices.

Introducing . . .

a new Shallow Troffer Series by Sylvania— recessed lighting for today's building methods

For the aesthetically minded lighting designer, who has to cope with the modern trend to lower ceilings and shallower plenum spaces . . . here is a new approach to recessed lighting. It's Sylvania's new Shallow Troffer Series, fixtures which measure only 5½" from top to bottom—and, in many cases, require no more space than that for mounting!

Available in a variety of models, in both one- and two-foot widths, the Sylvania Shallow Troffer makes this popular form of lighting *practical and usable* in all new buildings, with full illumination efficiency. The units are fully recessed. Unsightly latches are buried. Even the hinges don't show . . . only the clean straight lines of the exposed portion of the framing, and the attractively styled shielding.

Sylvania Shallow Troffers are carefully engineered to utilize the full plenum space. Lay-in type troffers are provided for Z-spline and inverted-T ceilings. Exclusive *snap-up hanger* provides quick, secure mounting for most other types of acoustical ceilings (see sketches below). Ask your Sylvania Fixture Specialist for full details, or write direct for FREE new folder of specification data.

SYLVANIA ELECTRIC PRODUCTS INC.
Dept. F50, Lighting Division—Fixtures
One 48th Street, Wheeling, W. Va.

SYLVANIA

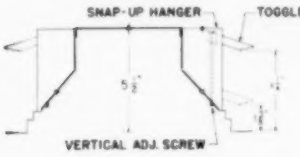
Fluorescent Lighting Fixtures and Systems

Best fixture value in every price range

LIGHTING • TELEVISION • RADIO • ELECTRONICS • PHOTOGRAPHY • ATOMIC ENERGY • CHEMISTRY-METALLURGY

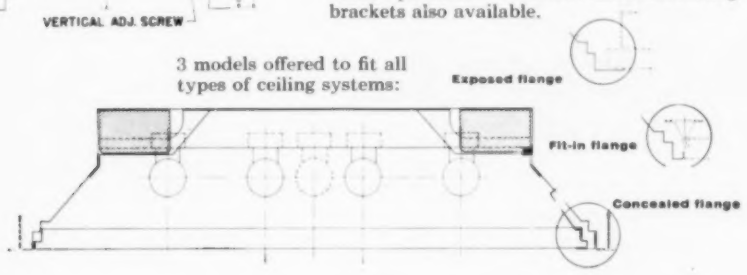
INDIVIDUALLY MOUNTED troffers, imaginatively arranged, combine attractive design with good basic light distribution for company cafeterias and lounges.

STRIKING, PLEASANT ACCENT for an up-to-date building corridor: Sylvania recessed lighting troffers continuous-row mounted with acoustical ceiling materials.

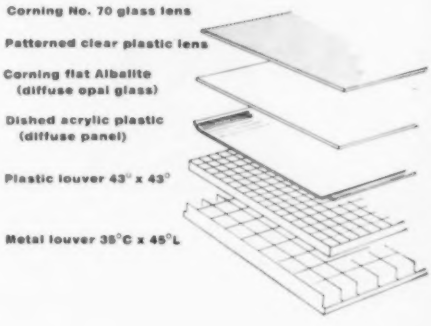


NEW 5½" HIGH TROFFER utilizes full plenum space. Exclusive *snap-up hanger*, with vertical adjusting screw, provides secure side-mounting for acoustical ceilings with support elements parallel to troffer. End-mounting brackets also available.

3 models offered to fit all types of ceiling systems:



ALL STANDARD TROFFER SHIELDINGS


Corning No. 70 glass lens
Patterned clear plastic lens
Corning flat Albalite (diffuse opal glass)
Dished acrylic plastic (diffuse panel)
Plastic louver 43° x 43°
Metal louver 38°C x 45°L

"Glare-less" Lighting with Mercury Uplight Units
Abolite's 24" wide Alzak aluminum uplight fixtures used with H 400-RC1 mercury lamps. Ceiling height is 35'; fixture height, 27' 10", with 20' spacing. 90% of lamp's lumens are useful. Average footcandle level is 35.

Now Abolite brings "office type" eye comfort to...

INDUSTRIAL HIGH BAY LIGHTING

Abolite open-top units direct only a small amount of light (18%) upward, but it makes a big difference in eye comfort. Dark ceiling shadows are washed away—there's no sharp contrast of bright light against black background. And glare is reduced still more by 35° lamp shielding. As a result, eye fatigue is reduced—workers are more efficient.

Abolite's modern air-swept design also reduces maintenance costs because air circulating through the fixture sweeps it clean of dulling dust.

There are three Abolite uplight units for high bay lighting: 18" and 24" diameter Alzak aluminum fixtures for use with 400 and 1000 watt mercury lamps and 18" Alzak aluminum fixtures for 500 watt incandescent lamps (ideal for gymnasium lighting). For full information on these units, see Sweet's Industrial Construction File, 12i/AB.

ABOLITE *Lighting*

THE JONES METAL PRODUCTS COMPANY
West Lafayette, Ohio

Attendance award — to New Orleans, of course. J. M. Gensberger, right, accepts the trophy from J. D. Mitchell, past Regional Vice-President of the Southeastern Region.

President Kirk Reid and I.E.S. Technical Director C. L. Crouch between sessions at the Little Rock Conference.

(*Continued from page* 23A)

Judges: South Central, Class I: Jan Reynolds, Carl Evans, Ruby Redford
Class II: C. L. Crouch, E. M. Yandell, Rawland Blaylock
Southeastern Contest, Class I: May Love Gale, Edna Fortier, Cecil Paslay
Class II, C. F. Berdon, Paul F. Cratin, L. F. Stout

Two luncheon sessions were part of the conference program. One, on the first day, featured President Reid as speaker. On Friday the Sustaining Members Luncheon honored these members, with the Region's Sustaining Members receiving special recognition. Mr. Crouch's talk of the New Approach to Footcandle Levels was given at this session, rather than the regular program, to afford them an opportunity of hearing it. Another gracious thought.

Little Rock attracted a fairly large ladies attendance. Weather notwithstanding (and it rained), they had a chance to see how beautiful a state Arkansas is. On Thursday they toured via special bus, to Hot Springs National Park. This trip included lunch at Hot Springs, a wonderful afternoon in local antique shops and a tour of West Mountain. They returned to the Lafayette in time to join the men at the informal cockail party which preceded the banquet and dance in the hotel penthouse.

The banquet, of course, was in honor of President and Mrs. Reid. As a token of this, the two Regions presented them with a beautiful silver tray.

Details of the program, and the people responsible for its success:

Thursday, April 24

Morning Session — Presiding, R. C. Pilcher, Chairman, Arkansas Chapter.
Call to Order — John S. Williams, General Conference Chairman.
Welcome to Arkansas—W. M. Shepherd, Vice-President, Arkansas Power & Light Co.
Progress Report on Membership, Brooks Chassaing, Chairman, National I.E.S. Membership Committee.
Properties of Light Stabilized Polystyrene for the Lighting Industry — William J. Fitzgerald, Plastics Application Division, Koppers Co.
Lighting Today's Classrooms, R. G. Slager, Sylvania Electric Products Inc.
President's Luncheon — Presiding, James W. White, Palmetto Section.
President's Message, Kirk M. Reid, President, Illuminating Engineering Society.
Afternoon Session — Presiding, H. G. McMullen, Chairman, Mid-South Chapter.
Discussion to Provoke Questions and Answers to Store Lighting Problems — George Gilleard, Curtis Lighting, Inc.
Lighting Churches and Public Buildings — Edward Rambusch, Rambusch Decorating Co.
Industrial Application Trends with High Output Sources — Russell D. Churchill, General Electric Co.

Friday, April 25

Morning Session — Presiding, G. W. Drane, Chairman, Mississippi Chapter.
Luminous Ceiling Designs, H. G. Blum, Luminous Ceilings, Inc.
Residential Lighting Session — G. W. Drane, Chairman, Mississippi Chapter.
Brighter Living, Miss Jan Reynolds, Sylvania Electric Products Inc.
Current Home Lighting Products and Application Ideas, Miss Eve Freyer, Westinghouse Electric Corp.
Street Lighting Session — Presiding, J. M. Gensburger, New Orleans Section.
Ballasting Fluorescent and Mercury Street Lighting Equipment, Joseph C. Yeager, Line Material Industries.
The Fight for Lights for Urbanites, A. D. Harrington, Outdoor Lighting Dept., General Electric Co.
Sustaining Members Luncheon — Presiding, Ray A. McMichael, Chairman, Suwannee River Chapter.
New Approach to Footcandle Recommendations, C. L. Crouch, Technical Director, Illuminating Engineering Society.
Afternoon Session — Presiding, Walter C. Fink, Chairman, Georgia Section.
MMILJ Contest.

COMMITTEE CHAIRMEN

General Conference Chairman..John S. Williams
Budget.....C. T. Magruder
Secretary.....W. R. Simpson
Papers and Programs.....Paul Cratin
Attendance .....Ernest Efird
Hotel.....Jack Ketzcher
Entertainment.....Curtis Stout
Ladies' Activity .....Robert Pilcher
Transportation.....J. T. Wynne
Arrangements.....B. A. Byles

(*News continued on page* 28A)

I.E.S. National Technical Conferences

1958 — August 17-22 — Royal York Hotel, Toronto, Ontario
1959 — September 7-11 — Hotels Fairmont and Mark Hopkins, San Francisco, California
1960 — September 11-16 — Penn Sheraton Hotel, Pittsburgh, Pennsylvania
1961 — September 24-29 — Chase Park Plaza Hotel, St. Louis, Missouri
1962 — September 9-14 — Statler-Hilton Hotel, Dallas, Texas

"Round table" agreement, for every detail was the method used for successful operation of the Southwestern Regional Conference, Shreveport. Note string ties identified the committee, who are, clockwise, R. C. Jackson, Treasurer; V. C. McFarland, Secretary; John Bowen, Registration; M. H. Perkins, Program; Ralph P. Nix, Publicity; J. G. Harriss, Jr., General Chairman; R. D. Madden, Lighting and Decoration; Paul L. Osteen, Vice-Chairman; C. D. Ham, host Chapter Chairman; R. G. Flowers, Hotel; A. W. Wheeler, Entertainment; Roger C. Gardner, Jr., MMILJ Contest. Missing from the picture are Rosemary Ham and Alice Mae Lothrop, Ladies Committee, and Reuben K. Lothrop, Regional V-P., who was hospitalized just prior to the Conference.

Southwestern Regional Conference

Date: April 28-29, 1958
Place: Washington-Youree Hotel
Shreveport, La.
Attendance: 175

Percentage-wise this may turn out to be the best attended conference of 1958. Close to 50 per cent of the entire Region's membership is represented in the registration. This may reflect well on the Region's individual members. Real credit, however, should go to the "Round Table" of committee men who apparently didn't overlook a single item which could contribute to the success of their conference. A system of team work was established quite early, with the agreement that every action taken throughout preconference planning would receive full round table discussion. Some of these actions: A beautifully-prepared portfolio sent as early as February to President Reid. This included personal letters to both Mr. and Mrs. Reid, a list of all the officers connected with the conference, a time table of all presidential appearances, interviews, etc., and many other items of information of great value to a traveling president. During the conference, a Louisiana string tie identified this committee for any further service.

Press coverage was also very professionally handled. Shreveport papers were briefed well ahead, on the nature of the meeting, its possible interest to readers, with previews of what the speakers had to say of interest to the general public. Shreveport's *Journal* assigned reporters and a photographer to cover the conference, and arranged an interview with President Reid. Publicity Chairman Ralph P. Nix and the rest of his round table buddies did a wonderful job for I.E.S.

Local custom. Kirk Reid gets his tie cut off by Gerry Harriss, to be replaced with indigenous string tie. Straw planters hat completed the ceremony making the president a Louisiana colonel.

All of this is rather remarkable when it is realized that Ark-La-Tex (host to to this big meeting) is a small Chapter of 41 members, and that the General Chairman (J. G. Harriss, Jr.) and most of his "table" had never experienced, even as delegates, a regional or national meeting. They scored high, in all areas, for the Southwestern Region.

The Region suffered one disappointment, however. Just before the conference, their Regional Vice-President, Reuben K. Lothrop, was taken to the hospital for an operation. A large card circulated the conference both days, to collect good-will signatures for his consolation.

Past Regional V-P John Felton, filled in for Mr. Lothrop as chairman of the large (21 officers) Local Activities Meeting which preceded the conference. The LAC meeting was a feature of all of the conferences, the Southwestern session being typical of the advance planning and regional reporting which makes them so valuable to incoming local officers. Notes are compared, as one example, on ways and means to get new members (in Tulsa

(Continued on page 31A)

THESE AUTHORIZED DISTRIBUTORS CAN HELP YOU SOLVE YOUR LIGHTING PROBLEMS

ALABAMA
Birmingham: Mayer Elec. Sup. Co.
ARIZONA
Phoenix: Brown Wholesale Elec.
CALIFORNIA
San Francisco: California Elec. Sup. Co.
COLORADO
Denver: Central Elec. Sup.
CONNECTICUT
Bridgeport: B. M. Tower
Hartford: Beacon Light & Sup. Co.
New Haven: Grand Light & Sup. Co.
New London: United Elec. Sup. Co.
Stamford: Marie Co.
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O. R. Evans & Bros.
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Miami: Farrey's Whsle. Hdwe. Co.
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Atlanta: Atlanta Ltg. Fix. Noland Co.
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Englewood Elec. Sup. Co.
Hawkins Electric
Hyland Elec. Sup. Co.
Wholesale Elec. Sup.
Elgin: Fox Elec. Sup.
Rockford: Englewood Elec. Sup. Co.
Springfield: Springfield Elec. Sup.
INDIANA
Ft. Wayne: Mossman-Yarnelle Co.
Gary: Englewood Elec. Sup. Co.
So. Bend: Englewood Elec. Sup. Co.
IOWA
Des Moines: Weston Lighting Co.
KANSAS
Kansas City: W. T. Foley Elec. Co.
KENTUCKY
Paducah: Ohio Valley Sup.
LOUISIANA
Baton Rouge: Electrical Wholesalers
New Orleans: Interstate Elec. Co.
MAINE
Bangor: Standard Elec. Co.
Portland: Holmes Elec. Supply Co.
MARYLAND
Baltimore: Atlantic Illuminating Co.
MASSACHUSETTS
Boston: Mass. Gas & Elec. Light Co.
Henry L. Wolfers Inc.
Fitchburg: Service Elec. Sup. Co.
Pittsfield: Carr Supply
Springfield: Eastern Elec. Sup.
Worcester: Atlantic Elec. Sup.
Benjamin Elec. Sup.
MICHIGAN
Detroit: Madison Elec. Co.
Michigan Chandelier Co.
Flint: Royalite Co.
Grand Rapids: Purchase Elec. Sup. Co.
Pontiac: Standard Elec. Co.
Saginaw: Standard Elec.
MINNESOTA
Duluth: Northern Elec. Sup. Co.
Minneapolis: Charles A. Anderson & Co.
Northland Elec. Sup. Co.
St. Paul: Lax Elec. Co.
MISSOURI
St. Louis: M. K. Clark
NEBRASKA
Omaha: Electric Fix. & Sup. Co.
NEVADA
Reno: Western Elec. Dists. Co.
NEW HAMPSHIRE
Portsmouth: Mass. Gas & Elec. Light Co.
NEW JERSEY
Atlantic City: Franklin Elec. Sup. Co.
Camden: Camden Elec. Fix. Co.
NEW YORK
Albany: Havens Elec. Co. Inc
Binghamton: Freije Elec. Sup. Co.
Buffalo: Buffalo Incan. Light Co. Inc.
Niagara Falls: Hysen Sup. Co.
Poughkeepsie: Electra Sup. Co.
Rochester: Rowe Electric Sup. Co.
Syracuse: Superior Elec.
NORTH CAROLINA
Charlotte: Independent Elec. Sup.
Durham: Noland Co.
Greensboro: Elec. Sup. & Equip. Co.
Kinston: Kinston Elec.
Winston-Salem: Noland Co.
OHIO
Akron: The Sacks Elec. Sup. Co.
Canton: The Electric Sales
Cincinnati: B. & B. Elec.
Cleveland: H. Leff Electric
Columbus: Elgee Elec. Co.
The Loeb Elec. Co.
Dayton: Duellman Elec. Co.
Toledo: Gross Elec.
Youngstown: Mart Industries
OKLAHOMA
Tulsa: Lawson Elec. Co.
PENNSYLVANIA
Allentown: Coleman Elec. Co.
Erie: Kraus Elec. Co.
Harrisburg: Fluorescent Sup. Co.
Hazleton: Power Elec. Co. Inc.
New Castle: Midwestern Elec. Co.
Philadelphia: Ace Lighting Fix. Co.
Gold Seal Elec. Sup. Co.
Sylvan Elec. Fix. Co.
Pittsburgh: Allied Elec. Sup. Co.
Argo-Lite Studios
Doubleday-Hill Elec. Co.
Wally Elec. Sup. Co.
Reading: Coleman Elec. Co.
Scranton: Lewis & Reif
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Huntington: West Virginia Elec. Co.
Wheeling: The Front Co.
WISCONSIN
Appleton: Moe Northern Co.
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WASHINGTON
Seattle: Seattle Lighting Fix. Co.
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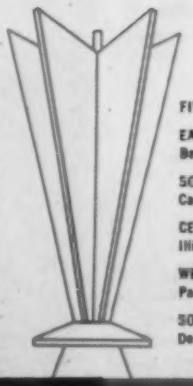

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(Continued from page 28A)

they reward men obtaining applications with a lapel pin); how to conduct a successful lighting course (Houston graduated 174 last winter); expansion (a Residence Lighting Forum is a-forming in Corpus Christi). Panel meetings were reported popular. Ditto dinner meetings, especially with a cocktail hour. Cliff Ham, Chairman of the Ark-La-Tex Chapter, filled in for Mr. Lothrop at the opening session address of welcome.

Two luncheon sessions on the conference program were a good idea. The first one featured President Reid as speaker. Next day's buffet had a "church supper" quality, strong on fellowship.

Southwestern put a lot into MMILJ. A Regional chairman for this project alone (Roger C. Gardner, Jr.) provided good organization. The contest was held during the first session, for full attendance, and featured four commercial entries and three residential. The winners:

Class I

First: Marguerite Borelli, Central Oklahoma Chapter (Wm. Irving, proxy)

Second: J. G. Harriss, Jr., Ark-La-Tex Tex Chapter

Third: Lucile A. Payne, North Texas Section (Ruth Patterson, proxy)

Class II

First: Leslie E. Hamilton, North Texas Section

Second: J. G. Harris, Jr., Ark-La-Tex Chapter

Third: Keith Taylor, Panhandle Chapter (Thomas Lynn, proxy)

Judges were: Class I—Mildred Peterson, Jan Reynolds, Ruby Redford; Class II—B. L. Guess, C. L. Crouch, R. L. Oetting.

(Continued on page 33A)

Local activities in the Southwest are well planned for the coming year. Section/Chapter officers met all Sunday afternoon at Shreveport, prior to the Southwestern Regional Conference.

Southwestern Conference had largest number of ladies (55) of any of this year's Regional meetings (so far). First on active program — kaffee klatch.

Belated award. Certificate of Appreciation for service as Regional V-P some years ago is presented to Floyd Covington, right, by Colonel Reid.

Chairman Gerry Harriss, Jr. (right) also thanked for outstanding service. Ark-La-Tex Chairman Cliff Ham presents desk pen on behalf of Southwestern Region.

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of indoor mercury lamp ballasts in the industry

PRIMARY VOLTAGE RANGES AVAILABLE*				
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1-100 watt	4	1	NONE	NONE
1-175 watt	4	NONE	NONE	NONE
1-250 watt	4	1	NONE	NONE
1-400 watt	4	4	4	2
1-400 watt Low Temp.	4	NONE	1	1
2-400 watt	4	4	NONE	3
1-700 watt	3	NONE	NONE	3
1-1000 watt (H12)	4	4	NONE	3
1-1000 watt (H15)	3	3	NONE	1
CONSTANT WATTAGE				
1-100 watt	4	NONE	NONE	NONE
1-175 watt	4	NONE	NONE	NONE
1-250 watt	4	NONE	2	NONE
2-250 watt	NONE	NONE	2	NONE
1-400 watt	4	NONE	5	NONE
2-400 watt	4	NONE	6	NONE
1-700 watt	4	NONE	4	NONE
1-1000 (H12)	4	NONE	4	NONE
1-1000 (H15)	4	NONE	5	NONE

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SEND FOR COMPLETE CATALOG—

containing all technical information for above voltage ranges

Jefferson ELECTRIC COMPANY

Bellwood, Illinois

(*Continued from page* 31A)

Being fourth on the circuit, several speakers from previous programs were also on the technical program at Southwestern (already reviewed). Together with a number of southwestern speakers this made for a strong technical presentation. Discussion was brisk, especially for the School Lighting session Tuesday morning. This eventually had to be cut off, to hold the conference to two days.

Socially this was definitely a fun conference. Nobody got a break on the weather, which dealt up storms and floods without cease, but the only disappointment in this was to the local people who regretted not being able to present Louisiana in April to its best advantage. The ladies, and there were 55 from out of town, had a wonderful time anyway. On Monday they formed car pools to have coffee together at the beautiful Cross Lake home of Mrs. W. S. Evans. From there they drove to the Shreveport Club for luncheon, and back in time for a dinner dance which was held at the Washington-Youree Hotel.

This was a real party. President and Mrs. Reid were guests of honor at the reception which preceded it. The Region also presented them with a gift memento, a beautiful antique silver tea pot. President Reid was formally initiated as a Louisiana Colonel during dinner. This ceremony calls for cutting off this Yankee's tie, replacing it with the local string variety, and topping all this with a typical planter's hat. He loved it, as did the audience. Nobody left this party early — the whole atmosphere of it was merry.

A record of the technical program and personnel includes:

Sunday, April 27

Early Bird Golf.
Local Activities Meeting.
President's Reception — Crystal Ball Room.

Monday, April 28

Opening — First Session Chairman — Arthur Rice, Chairman, San Jacinto Section.
Welcome — C. D. Ham, for R. K. Lothrop, Southwestern Regional Vice-President.
Address — J. Robert Welsh, President, Southwestern Gas and Electric Co.
New Illumination Levels — C. L. Crouch, Technical Director, I.E.S.
Second Session Chairman — Thomas L. Moore, Chairman, North Texas Section.
My Most Interesting Lighting Job Contest — Roger C. Gardner, Jr., Ark-La-Tex Chapter.
Luncheon — Chairman, William G. Darley, Chairman, Alamo Section.
Address — K. M. Reid, National President, I.E.S.

Monday Afternoon

Session Chairman—Frank Donahue, Chairman, Panhandle Chapter.
Brighter Living — Jan Reynolds, Sylvania Electric Products Inc., New York, N. Y.
Church and Public Building Lighting—Edward Rambusch, Rambusch Decorating Co., New York, N. Y.

Monday Evening

Dinner Dance — Crystal Ball Room.
Toastmaster — Clifford D. Ham, Chairman, Ark-La-Tex Chapter.

Tuesday, April 29

Session Chairman — W. T. Walters, Chairman, Oil Capital Section.
School Lighting — Lloyd L. Waite, Building Coordinator and Assistant Superintendent of Schools, Caddo Parish, Louisiana.
Industrial Lighting — George Jamison, Crouse-Hinds Co., Houston, Texas.
What's New in Lighting Sources — R. D. Churchill, General Electric Co., Cleveland, Ohio.
Fellowship Buffet Luncheon.

Tuesday Afternoon

Session Chairman — Lloyd Boyles, Chairman, Central Oklahoma Chapter.
Plastics and Lighting — F. C. Winkler, Westinghouse Electric Corp., Cleveland, Ohio.
Application Trends with Extremely High-Output Fluorescents — R. D. Churchill, General Electric Co., Cleveland, Ohio.

SOUTHWESTERN REGIONAL CONFERENCE

R. K. Lothrop, Regional Vice-President

General Chairman.....J. G. Harriss, Jr.
Vice-Chairman .....Paul L. Osteen
Secretary.....Vernon C. McFarland
Treasurer.....Robert C. Jackson, Jr.

COMMITTEE CHAIRMEN

Attendance and Publicity.....Ralph P. Nix
Entertainment.....A. W. Wheeler
Hotel.....Ralph G. Flowers
Ladies.....{ Mrs. Clifford D. Ham / Mrs. R. K. Lothrop
Lighting and Decorations.....R. Don Madden
M.M.I.L.J. Contest.....Roger C. Gardner, Jr.
Program and Papers.....M. H. Perkins
Registration and Reception.....John Bowen

CHAPTER AND SECTION CHAIRMEN

William G. Darley.....Alamo Section
Clifford D. Ham.....Ark-La-Tex Chapter
Lloyd Boyles.....Central Oklahoma Chapter
A. N. Saxon.....Coastal Bend Chapter
Thomas L. Moore.....North Texas Section
W. T. Walters.....Oil Capital Section
Frank Donahue.....Panhandle Chapter
Arthur Rice.....San Jacinto Section
Stewart O. Norris.....South Plains Chapter

Midwestern Regional Conference

Date: May 1-2, 1958
Place: Hotel President, Kansas City, Mo.
Attendance: 208

Most predominant "atmosphere" at any Midwestern Regional Conference is always *experience*. These people are old hands at successful meetings. This reputation apparently attracts to them nationally-known speakers of impressive caliber (see program). Chief flavor, to repeat the theme, was most definitely high-level program excellence.

At Kansas City, another ingredient was apparent, however. This can only be described as enthusiasm — the eager, dedicated, genuine interest of the Heart of America committee in providing a truly successful conference. Teamed with the experience of giants like the Chicago, St. Louis and Twin City Sections, it all added up to a very good meeting. A preview of similar success next year, and the year after that, was felt too. The 1959 Conference is scheduled for Peoria, and in 1960, Sioux City. Members of both these Sections were already beating the drum for their conferences. They arrived in Kansas City with promotional leaflets, prepared material, paper corncobs (for the Cornhusker Section in 1960) and a plastic bag full of small gifts for every delegate at the K.C. meeting. Enthusiasm which is already full blast a year, and even two years in advance, just can't miss.

K. C. Mayor Roe Bartle, bestows Key to the City on Conference Chairman Bing Kindell.

From the start, the opening session set the pace for the program, seriousness with a light heart. The meeting opened with prayer. The invocation was given by Dr. Richard M. Trelease, Rector of St. Paul's Episcopal Church. Opening address, by Mayor H. R. Bartle, however, had the audience laughing almost continuously. Even the Republicans agreed that this man could run for almost any office, and General Chairman B. F. (Bing) Kindell will probably have to vote for him now that he has been given a key to the city. This latter was an interesting ceremony during Mayor Bartle's

(*Continued on page* 34A)

Registration of 218 delegates was handled by Kathleen Ricketts, Graybar Electric Co.

Two of the speakers who distinguished the high-power technical sessions: H. L. Logan (photo at left), Holophane Co., New York, and (right) George J. Taylor, Day-Brite, incoming I.E.S. President.

Success lights the faces of the three top directors at the Midwestern Regional Conference. l. to r. General Conference Chairman B. F. (Bing) Kindell; Joseph Schneller, Regional V-P; Tom Sidlo, Chairman, host Section, Heart of America.

(*Continued from page 33A*)

address, and was definitely not facetious. The gesture reflected well on the esteem with which IES is held in this area.

Another pace-setting address at the opening session was the Report to the Region by Regional V-P Joseph Schneller. A major consideration for future officers of this Region, he felt, was the possibility of dividing the Region for more appropriate representation of the area's 1600 members. A second officer of the Society at the opening session was Director Brooks Chassaing, national chairman of the Membership Committee. Mr. Chassaing's presentation at this and a number of other Regional Conferences was extremely well thought out. As with other Regions, his talk covered membership facts and figures pertinent to the particular region; charts showing membership growth in this region plotted against national membership growth over the years—a most interesting and significant method of discussing this subject.

MMILJ has always been big in Midwestern. In both classes there were sixteen entries, representing every Section and Chapter in the Region, no exceptions. Their organization, as with some of the other more successful Regional contests, includes a chairman working exclusively on this project. This year's chairman was Don Ingwerson who devoted several months to the contest and m.c.'d the proceedings at Kansas City. Results of the contest are:

Class I — Residential

First Prize: William Kuhnke, Milwaukee Section

Second: Dorothy Davis, St. Louis Section

Third: Eldena Purcell, Indianapolis Section

Class II — Commercial

First Prize: Melvin Cohen, Chicago Section

Second: Donald E. Harrington, Indiana Section

Third: Thomas C. Sidlo, Heart of America Section.

Judges in the contest were, for Class I, Ed Kelsey, Gene Beggs and Ruby Redford; for Class II, R. R. Wylie, C. L. Crouch and R. D. Churchill.

The technical program speaks for itself, just by the names of the speakers. Obviously, the Heart of America Section went all out to further the education of those attending. The same could be said, however, of their wish to entertain their guests. Highlight of this was a cocktail party for IES, given by NECA Kansas City Chapter, and the President's Banquet by the Region which followed it. Kansas City steak was, of course, the menu. The Region's gift to their guests of honor, President and Mrs. Reid, was

(*Continued on page 36A*)

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WHEN you need it . . . WHERE you need it

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Features of this practical floodlight include: wide range of focusing through unique, adjustable dial mechanism; a free swinging cast aluminum cover ring and heat-resistant lens assembly for quick lamp changing and maintenance; weather-tight construction; horizontal and vertical degree adjustment; lead-in wiring furnished with water-tite cord gland. Optional use of 300 or 500 watt incandescent Mogul base lamps or mercury vapor lamps. Wide variety of accessories for pole and wall mounting.

For Buildings

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Also Manufacturers of:

"ST" Series Connectors

Malleable Iron Unilets

Industrial Lighting Equipment

Automatic Reelites

(*Continued from page 34A*)

a package of 16 Kansas City steaks, to be shipped later. This gift may not last long, but it will certainly be enjoyed and remembered.

A combination of education and pleasure was the May 1 luncheon. In charge was T. C. Sidlo, Chairman of the Heart of America Section; featured speaker was IES President Kirk Reid.

The 50 ladies attending the conference had their own program of fun, in addition to the above. Ray Perry, Transportation Chairman, arranged for a conducted tour of points of interest in K. C., including William Rockhill Nelson Gallery of Art, Liberty Memorial and the famous Country Club Plaza shopping center. They all went through the Hallmark greeting card factory and had luncheon at the Blue Hills Country Club. Inescapable conclusion for all concerned, both men and women — "Everything's up to date in Kansas City."

For the record, the technical program and personnel:

May 1 — Morning Session

Presiding — B. F. Kindell, Conference Chairman.
Invocation — Doctor R. M. Trelease, Rector, St. Paul's Episcopal Church.
Welcome to Kansas City — Hon. H. Roe Bartle, Mayor of Kansas City.
Regional Vice-President's Report — Joseph A. Schneller, Midwestern Regional Vice-President.
My Most Interesting Lighting Job Contest — Don Ingwersen, Contest Chairman, presiding.

May 1 — Luncheon Session

Presiding — T. C. Sidlo, Chairman, Heart of America Section.

Framed — in the seven foot doorway, Midwestern Region members Charles Zurheide, St. Louis, and John Trave, Kansas City. Relative size of photographer precluded sharp focus.

Report to the Membership — Kirk M. Reid, National President.

May 1 — Afternoon Session

Presiding — Ed Stone, Holophane Co., Inc.
How Does Your Lighting System Rate in Quality and Comfort? — Henry L. Logan, Holophane Co., Inc.
Industrial Lighting and Where It's Going — George Taylor, Day-Brite Lighting, Inc.
Church and Public Building Lighting—Edward Rambusch, Rambusch Decorating Co.

May 1 — Evening Session

Cocktail Hour — Courtesy The Greater Kansas City Chapter of the National Electrical Contractors Association.
President's Banquet — B. F. Kindell, Midwestern Regional Conference Chairman, presiding.
MMILJ Regional Winner Awards — Don Ingwersen, Contest Chairman.

May 2 — Morning Session

Presiding — Professor O. D. Hung, Kansas State College, Manhattan, Kans.
What's New in Light Sources and Application Trends in High-Output Fluorescent and Mercury Lamps — R. D. Churchill, General Electric Co., Lamp Department.
New Basis for Footcandle Levels — C. L. Crouch, Technical Director, I.E.S.
Applications in School Lighting — R. G. Slauer, Sylvania Electric Products Inc.

May 2 — Afternoon Session

Presiding — Frank Feagans, Kansas City Power and Light Co.
Brighter Living, and Residential and Garden Lighting — Jan Reynolds, Sylvania Electric Products Inc.
Lighting — the Most Important Tool in Merchandising — C. O. Osborn, Westinghouse Electric Corp.

CHARTER of Chapterhood is accepted by Thomas H. Condon, Chairman of the new Ozark Chapter in Springfield, Mo. Presentation was by President Reid, and took place at the Midwestern Regional Conference in Kansas City.

Ozark Chapter Established

Springfield, Missouri is the site of the Society's newest Chapter (No. 81). Petition for its Charter was made to Council, April 30, at its meeting in Kansas City, by Regional V-P Joe Schneller. Parent Section, St. Louis, also gave its blessing to the establishment of the Chapter, releasing members and territory.

Formal presentation of the new Ozark Chapter Charter was made the following day during ceremonies at the Midwestern Regional Conference banquet. I.E.S. President Kirk M. Reid presented the Charter to the group's first chairman, Thomas H. Condon, City Utilities of Springfield, Mo. (see cut). Secretary for the new group will be Harold A. Stohl, Lamons Electric Co., Springfield, Mo.

CONFERENCE EXECUTIVE COMMITTEE

Joseph Schneller ..... *Regional Vice-President*
B. F. Kindell ..... *General Chairman*
Frank Taylor ..... *Vice-Chairman*
John Krall ..... *Secretary*
Frank Taylor ..... *Treasurer*

COMMITTEE CHAIRMEN

M. A. Havenhill ..... *Papers and Program*
Norman Taylor ..... *Entertainment and Social*
C. L. Arehart, Jay Meara ..... *Attendance and Publicity*
Bob Hollis ..... *Decorations and Display*
G. S. Young ..... *Finance*
Ray Perry ..... *Transportation*
Roger Bessmer ..... *Registration and Reception*
Francis Miles ..... *Hotel*

SECTION/CHAPTER CHAIRMEN

Central Illinois Chapter, Orlo Oberlander
Chicago Section, Willis F. Carson
Cornhusker Section, Mark E. Lee
Heart of America Section, Thomas C. Sidlo
Indiana Section, Robert L. Peloquin
Iowa Section, Melvin H. Galbraith
Milwaukee Section, William C. Kuhnke
St. Louis Section, Richard D. Cohen
Twin City Section, G. William Frederick
Twin Ports Chapter, Parker Lowell

(*News continued on page 39A*)

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Designed in superb styling . . . a wonderful wedding of All-Brite's new recessed line with Holophane lenses. Write for catalogs, details.

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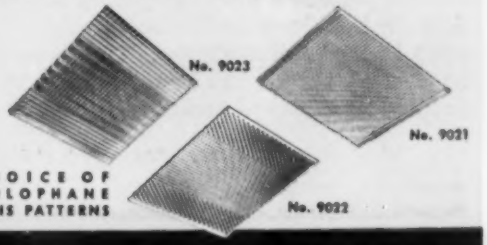
LIGHT OF THE WEST



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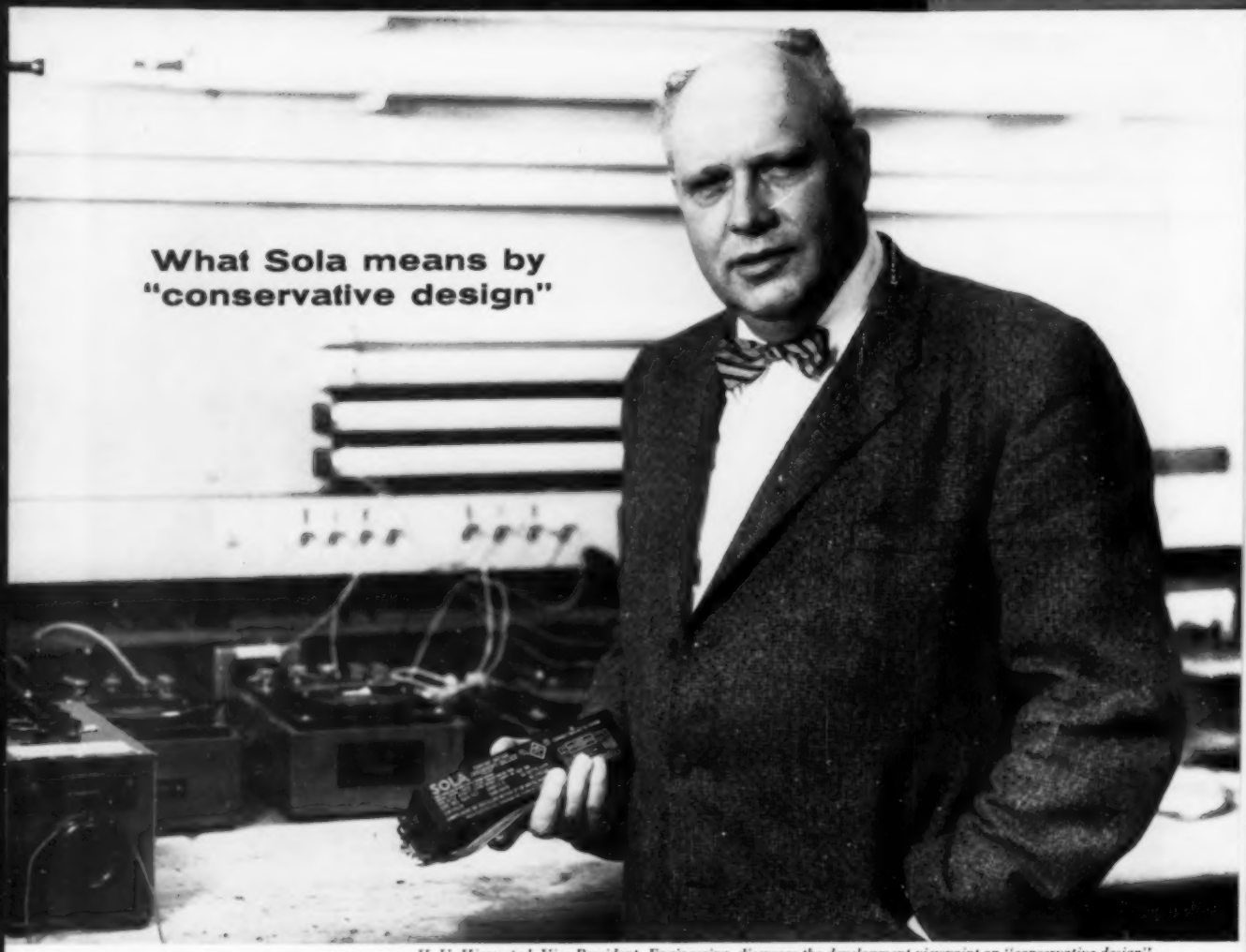

H. U. Hjermstad, Vice President, Engineering, discusses the development viewpoint on "conservative design"

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The atmosphere in Sola Electric engineering labs is pleasant, yet there is an undertone of restlessness. A paradox? Maybe. But it's one that we feel is understandable and desirable.

Any design engineer worth his salt is happy when he's turned loose in a well-equipped lab and told to produce the best fluorescent ballast possible. We tell him to take the "radical approach" to "conservative design". In other words, he's to "design in" *more* than is needed in materials and workmanship, so as to make sure a Sola ballast will deliver rated performance . . . *plus*. However, until he produces that hypothetical "perfect ballast" we will continue exploring new ideas . . . new approaches.

The Sola Constant Wattage Fluorescent Ballast you buy today is cool, quiet, and gives full lumen output and long lamp life. It is designed and built to surpass CBM standards. We sincerely believe it's the best on the market and we're constantly working to make it still better.

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SOLA

CONSTANT VOLTAGE TRANSFORMERS

REGULATED DC POWER SUPPLIES

MERCURY LAMP TRANSFORMERS

FLUORESCENT LAMP BALLASTS

(Continued from page 36A)

International Lighting Vocabulary Compiled by CIE

A new international vocabulary of lighting terms, the culmination of twenty years of study by a working party of the International Commission on Illumination (CIE), is now ready for distribution through the United States National Committee. It is printed in three languages: French, English and German, and was created for the purpose of facilitating communication between scientists the world over, who are working in illumination.

The publication contains 530 terms, with definitions, as well as numerous symbols and formulae. Its principal sections cover Radiation, Photometry, Colorimetry, Eye and Vision, Production of Light, Lamps, Auxiliary Apparatus, Lighting Techniques, Lighting Fixtures and Light Signals.

Volume 2 of the publication will be published in 1959. It will contain the same terms, without definitions, and will be printed in ten languages. These are: French, English, German, Danish, Dutch, Italian, Polish, Russian, Spanish and Swedish. The material will be arranged systematically with ten alphabetical indexes.

The United States National Committee has placed a prepublication order for the first volume, and is offering it at a reduced price. A limited number of copies is now available at $2.50 each. Price will probably be raised when the initial supply is exhausted.

Orders for the publication, with remittances payable to U. S. National Committee, CIE, should be sent to T. D. Wakefield, Treasurer, USNC, Vermilion, Ohio.

San Jacinto Lighting Course An Outstanding Success

A total enrollment of 174 made it necessary for the San Jacinto Section to offer its Lighting Training School in two sections — the auditorium seating only 100. And approximately 40 to 50 late applications had to be refused.

The course was designed for both new and experienced lighting salesmen and for engineers and draftsmen, covering new and improved light sources, methods of application, recommendations for higher lighting levels, and modern lighting equipment developments. Sound slide-films were supplemented by lectures, discussions and actual demonstrations of equipment. Instructors were engineers from the I.E.S. membership.

The eight-week course was presented in

(Continued on page 40A)

SCHEDULED EVENTS

June 23-24, 1958 — Great Lakes Regional Conference, Sheraton Hotel, Rochester, N. Y.

June 23-27, 1958 — American Institute of Electrical Engineers (Summer General Meeting), Buffalo, N. Y.

August 17-22, 1958 — Illuminating Engineering Society (National Technical Conference), Royal York Hotel, Toronto, Canada.

August 19-22, 1958 — American Institute of Electrical Engineers, Pacific General Meeting, Sacramento, Calif.

September 22-25, 1958 — Institute of Traffic Engineers (Annual Meeting), McAllister & Columbus Hotels, Miami, Florida.

October 8-10, 1958 — Canadian Electrical Manufacturers Association (14th Annual Meeting), Sheraton Brock Hotel, Niagara Falls, Canada.

October 10-11, 1958 — International Association of Electrical Inspectors (Canadian Section), Toronto, Ont.

October 13-14, 1958 — U. S. National Committee of the International Commission on Illumination (C.I.E.), Annual Meeting, Nittany Lion Inn, State College, Pa.

October 13-15, 1958 — National Electronics Conference, Inc., Hotel Sherman, Chicago, Ill.

October 19-24, 1958 — Society of Motion Picture and Television Engineers, Sheraton-Cadillac Hotel, Detroit, Mich.

October 20-24, 1958 — National Safety Council (46th National Safety Congress & Exposition), Chicago, Ill.

October 27-31, 1958 — American Institute of Electrical Engineers (Fall General Meeting), Pittsburgh, Pa.

November 10-14, 1958 — National Electrical Manufacturers Association (Annual Meeting), Traymore Hotel, Atlantic City, N. J.

November 18-20, 1958 — American Standards Association (9th Annual Conference on Standards), Hotel Roosevelt, New York, N. Y.

January 19-23, 1959 — American Institute of Electrical Engineers (Winter General Meeting), New York, N. Y.

March 1-4, 1959 — National Electric Sign Association, Morrison Hotel, Chicago, Ill.

March 30 - April 1, 1959 — Chicago Electrical Industry Show, Hotel Sherman, Chicago, Ill.

May 3-8, 1959 — Society of Motion Picture and Television Engineers, The Fontainbleau, Miami Beach, Fla.

May 24-29, 1959 — National Association of Electrical Distributors (51st Annual Convention), Conrad Hilton Hotel, Chicago, Ill.

June 22-26, 1959 — American Institute of Electrical Engineers, Summer and Pacific General Meeting, Seattle, Wash.

CERTIFICATES were given to graduates of the course on its completion May 1. Left to right in photo are: H. G. Hrivnatz, Chairman, Education Committee; H. F. Staacke, Vice-President, Houston Lighting and Power Co.; George Simpson of Graybar Electric, Vice-Chairman of the San Jacinto Section; G. W. Burgess, Sylvania Electric Products Inc.

(Continued from page 39A)

one two-hour session per week for each group. Graduation dinner was held on May 1, with Certificates of Merit awarded to those who had attended at least six classes. Certificates were given to 90 per cent of the enrollment.

The Education Committee, responsible for the success of the course, is made up of Chairman Harry G. Hrivnatz, E. C. Ober, Sumner Harris and R. C. Jung. Classes were held at the Houston Lighting and Power Co.'s Underground Service Center Auditorium. The course was co-sponsored by the utility.

GRADUATION was celebrated by dinner for those who completed the San Jacinto Lighting Course. Here H. F. Staacke addresses the group. Ninety per cent of the enrollment graduated.

2nd National Lighting Show Announced for 1959

Plans are already underway for the second National Lighting Exposition, which will be held March 1 through March 4, again at the New York City Coliseum. It is reported that 50 per cent of the exhibition space has been sold, prior to the first announcement.

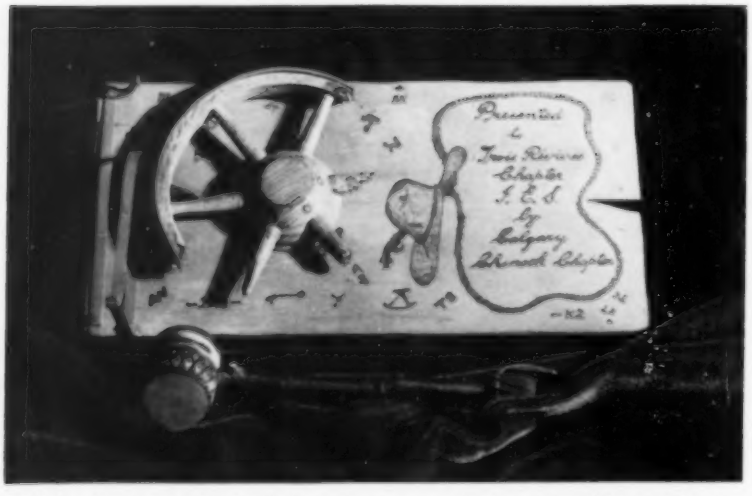
The second show, like the first, will be accompanied by technical symposiums on lighting techniques and installations. An honorary committee for topics and speakers has been named. Members of this committee are: Richard E. Cleary, Publisher and Editor of *Lighting;* Berlon Cooper, Eastern Editor of *Electrical Construction and Maintenance;* Abe H. Feder, Lighting Designer; Melanie Kahane, Interior Designer; Thomas Smith Kelly, Lighting Consultant; Morris Ketchum, Jr., Architect; Peter Muller-Munk, Industrial Designer; and Ruby Redford, Editor of ILLUMINATING ENGINEERING.

Sponsor of the exhibition will again be the Lighting, Lamps and Electrical Manufacturers Salesmen's Association, Inc. It will be produced by Harold Meyer.

Pioneer History Depicted In St. Maurice Valley Gavel

Early pioneers in southern Alberta and their history, including the famous Calgary Stampede, are commemorated in the gavel and base which the I.E.S. Chinook Chapter presented to the "next-youngest" St. Maurice Valley Chapter in Trois Rivieres, Quebec.

The gavel head is a replica of an Indian war drum and one end is covered with leather. On the base is a broken chuckwagon wheel, the hub of which is intended to accommodate the rapping of a gavel. The entire base is finished in antique silver gray with designs burned in. The random markings show cattle brands of the pioneer ranches in the area, and the iron work simulates railings and fittings of a chuckwagon. A lasso encircles the presentation inscription, ending in a traditional ten-gallon hat.



GAVEL of the St. Maurice Valley Chapter, a gift from the Chinook Chapter, depicts the history of pioneer Alberta.

Back Issues of I.E. Wanted

The Permagon Institute, of London, reports a need for a complete set of *I.E.S. Transactions* and ILLUMINATING ENGINEERING, from the first issue in 1906 to the end of 1957. If any reader has these back issues and wishes to dispose of them, he should send a list to the Institute, which will submit an offer. The Institute, a non-profit foundation for the furtherance and dissemination of scientific knowledge, is located at 4-5 Fitzroy Square, London, W.1, England. R. Bigwood is Administrative Secretary.

Society Organized on History of Technology

In an effort to assess the impact of technology on society, a group of interested scholars have joined to form the Society for the History of Technology. It will sponsor meetings at which various aspects of technological history will be investigated and will publish a quarterly journal, *Technology and Culture.* Publi-

(Continued on page 42A)

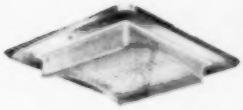
Brascolite 4' x 4' Silver Bowl Recess with Guth Gratelite Louver Diffuser

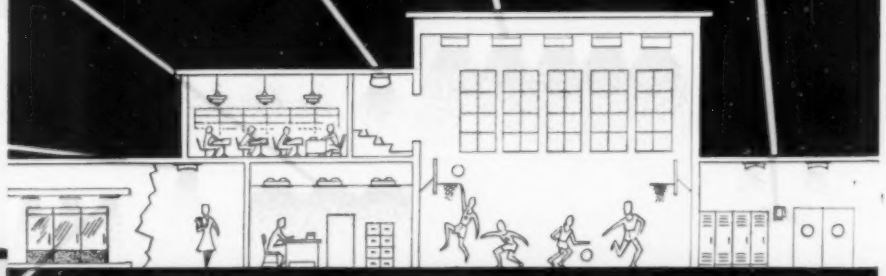
Brascolite Hinged Glass Drum Units with Alzak Reflectors

Brascolite Surface Gym Lights with Guard and Louvers

Brascolite Exit Signs—5 different Styles for All Requirements

Brascolite Square Recess Unit with Holophane Corridor Controlens





Brascolite Round Recess Unit with Corning Concave Lens

from entrance to exit...
and everywhere in between

Guth brascolite

THE LINE FOR EVERY INCANDESCENT LIGHTING NEED

Whatever the lighting job—large or small, simple or complex—the Guth Brascolite *incandescent* line offers a fixture for every purpose. Now, from one *complete* source, you can figure the entire installation, without having to search through numberless catalogs to find the fixture you need. And every Brascolite listing gives *"Pre-Formance Data"*—complete lighting curves, interflectance coefficients and mounting-to-spacing ratios!

Whether the job involves a school, hospital, industrial plant, office or store ... the Brascolite line and the comprehensive Brascolite catalog put the material you need right at your fingertips. Send for the Brascolite catalog today—a *complete* working tool for the *complete* incandescent line.

THE EDWIN F. GUTH COMPANY
2615 Washington Blvd. • St. Louis 3, Missouri

(*Continued from page* 40A)

cation is expected to begin in the fall of 1959.

The first program is being co-sponsored by the Humanistic-Social Division of the American Society for Engineering Education and is being held, June 16-17, at the University of California, Berkeley, with the following program:

June 16 — The Role of the Technical Museum in Engineering Education — Robert Multhauf, Smithsonian Institution.
Engineering Concepts in the Development of Thermodynamics — Thomas S. Kuhn, University of California.

June 17 — Relations of Science, Technology and Art in Nineteenth Century Building — Carl W. Condit, Northwestern University.
Technology and Cultural Values in American History — Edward Lurie, University of Michigan.

Chairman of the society's Executive Committee is Melvin Kranzberg, Case Institute of Technology, Cleveland, Ohio.

Council Actions Of General Interest

At the Council meeting held in Kansas City, April 30, a full agenda was covered, including several actions and reports of general current interest to members.

Something like 18 new technical committee reports are expected to be ready for presentation this year. This was reported by George Taylor, First V-P, for the technical program.

Two timely and useful booklets are close to completion, prepared by the Education Committee, Alston Rodgers, Chairman. These are "Exercises with Light" (for high school students), co-sponsored by the National Association of Science Teachers and "Careers in Illumination" also for students.

Brand new footcandle recommendations developed by the various technical committees based on the Blackwell researches (see ILLUMINATING ENGINEERING, April 1958, p. 9A), are now being studied. Council letter ballot and discussion were on the agenda for June Council meeting, and will be reported on.

Study is to be undertaken leading to the development of Section/Chapter program material.

Computer Methods Studied At Yale University

The Bureau of Highway Traffic at Yale University and the Institute of Transportation and Traffic Engineering, University of California, will jointly present a two-week course on "Introduction to Computer Methods for Highway and Traffic Engineers." The course will take place from July 7 to July 19, and will be held at Yale in New Haven, Conn.

It is designed to give practicing engineers a working knowledge of the application of high-speed computers to problems of traffic flow, traffic assignment, route location including grade and alinement calculations, and traverse calculations. Attention will be given to the solution of traffic-flow problems by simulation techniques.

Those attending the course will be given opportunities to program and operate the IBM 650 digital computer located on the Yale University campus. Students will also have an opportunity to visit other installations where a variety of computers will be demonstrated.

Tuition fee for the course is $150 (course materials included). Further information may be obtained from: Director, Bureau of Highway Traffic, Strathcona Hall, Yale University, New Haven, Conn.

leaves from the... HISTORICAL COMMITTEE'S SCRAPBOOK

Civilization on the Road

Today's resurgence of street and highway lighting recalls the fact that great civilizations and most military conquests have been built upon the foundation of the road. The pageantry of the American Highway has been a colorful parade of pony express riders, covered wagons, buggies, sleighs and bicycles, the interurban trucks and buses, and now the sleek motor palaces that purr over 500 miles of highway each day or night.

Americans are the most mobile people in history, even though the first "limited access" highway linked the Persian Gulf with the Mediterranean about 700 B.C., and kings of Babylon decreed death for those who placed signs or structures on the road, interferring with visibility. The Assyrian chariots bogged down because of traffic congestion in Nineveh long before the Romans (as they did) invented one-way streets, specified axle loads or limited travel to some 200 miles per day on their 50,000 miles of primary highways.

The first notable highway in the eastern United States, Route No. 1 or the Boston Post Road, built about 1700, permitted the mail express to make the run from New York to Boston in eight days, if the road was dry and the moon full. Horses were entrusted with most of the seeing tasks.

Long long before, the Camino Real of the Spanish Southwest and the Arcadian Highways of Canada were useable at night with the help of the horn lantern jigggling from the wagon-tongue.

The first Federal expressway, the "National Pike," (Cumberland Road) was built as far west as Ohio (U. S. 40) by 1838. Seventy years later, by 1908, the 26 million horses and 200,000 motor cars required little street lighting. However, by 1957, the sale of over 7,200,000 cars and trucks in this country (plus 70,000,000 "on the road" in North America) and the more than 9000 miles of divided highways (or 2000 miles of express toll superthroughways), fairly shouted for sure seeing and safe driving after dark.

In the 20 years that streets have been passably lighted, the death rate per 100 million vehicle-miles has dropped from 14.7 (1937) to 5.9 (1957).

The average modern motorist drives 10,800 miles per year — about one-third with his headlamps burning. For nearly ten miles of each day's average drive, he desperately needs good overhead lighting that will glare, neither into his eyes, or into his neighbor's.

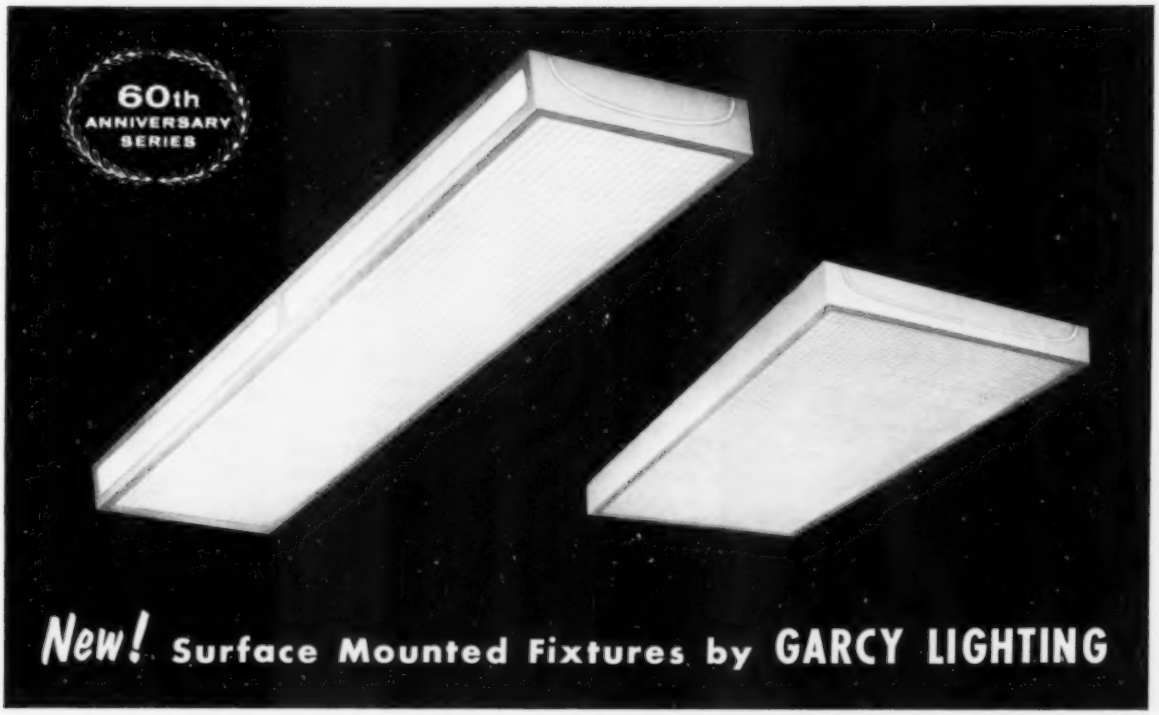
Street and highway lighting epitomizes the torch of civilization's progress. Kings Hammurabi, Cyrus and Nebuchadrezzar in the hundreds of years before Christ; the Caesars, Kublai Khan; the builders of the Camino Real or the Autobahns — even the Continental Congress—all found this out.

ABOUT PEOPLE

Walter Sturrock, Past-President of I.E.S., has joined the faculty of the Electrical Engineering Department of Alabama Polytechnic Institute, Auburn, Ala., where he is giving a course in Illuminating Engineering, in addition to his other duties. Mr. Sturrock recently retired from the General Electric Co., Nela Park, Cleveland.

Robert J. Sloan has been elected president of Crouse-Hinds Co., Syracuse, N. Y., succeeding **J. R. Tuttle** who continues as chairman of the Board of Directors. Election of **Raymond W. Cummings** as secretary has also been announced.

(*Continued on page* 45A)



New! Surface Mounted Fixtures by GARCY LIGHTING

- **2 or 4 lamp units, only 3½" deep**
- **Hinged one-piece enclosures**
- **Regular or translucent sides**
- **For 48" rapid start lamps**

Especially suitable for modern low ceilings, the 60th Anniversary Series embodies simplicity in design, glare-free visual comfort and efficient light utilization. This versatile series offers unique advantages to cost-conscious contractors.

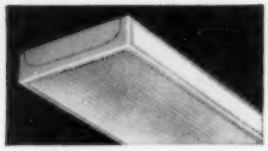
ONLY TWO BASIC PARTS TO INSTALL

1. Compact Chassis
2. One-Piece Enclosure

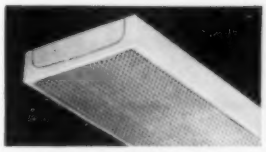
The lightweight chassis is easy to handle. Hinged enclosure is furnished ready for installation . . . no small parts to assemble.

Your Choice of these Distinctive Treatments

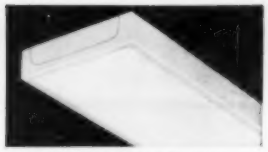
ALBA-LITE GLASS



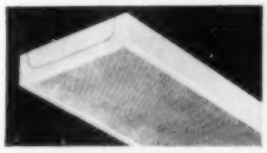
ONE-PIECE PLASTIC LOUVER



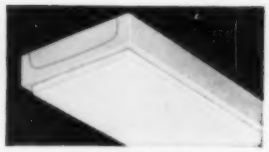
EXTRULITE CLEAR PLASTIC



FLAT PLEXIGLAS PANEL



LOW BRIGHTNESS LENS



DISHED PLASTIC

TRANSLUCENT SIDES

REGULAR SIDES

GARCY

Garden City Plating and Manufacturing Company
2473 Elston Avenue • Chicago 47, Illinois
In New York City—48 West 48th Street
In Los Angeles—Garcy Western Corporation, 3912 Broadway Place
In Canada:—Garcy of Canada, Ltd., 1244 Dufferin Street, Toronto

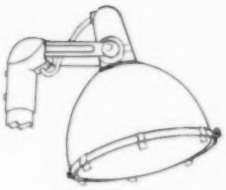
Revere Outdoor Lighting Report

Revere ELECTRIC MFG. CO.

Lighting an automobile sales lot

The Problem: To illuminate a long, deep sales area so that cars, signs, and buildings would attract attention and look more appealing to passers-by.

The Answer: Five poles, each mounting ten Revere No. 7403 *1000-watt* mercury floodlights on a No. 217-ZA bracket, were installed to provide the high level of lighting desired. Ten No. 3510-AL Revere Par Lamps are also mounted on each pole 10 feet above grade to highlight the color and beauty of the cars and create more sales appeal.

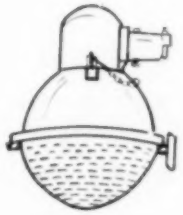


No. 7403 Floodlight

Lighting a city street

The Problem: To provide a lesser traveled secondary street with uniform, moderate-level lighting, in the most efficient, economical way possible.

The Answer: Revere Star-Lux incandescent street lighting luminaires were installed on converted concrete poles to provide efficient lighting at low cost. The Star-Lux uses up to 10,000 lumen incandescent lamps or 250 to 400-watt mercury lamps to provide any of the five standard A.S.A.-I.E.S. distribution patterns.



No. 2311-A/2363
Star-Lux Luminaire

Lighting a poster board

The Problem: To assure greater night visibility of an advertiser's poster board sales message by providing higher level, more uniform illumination.

The Answer: Revere Fluoresign outdoor luminaires with very high output fluorescent lamps were installed to give the high level of illumination desired. Reflector and lamp assembly may be positioned at any desired angle for uniform light distribution. Lamps give 10 times the rated life of incandescent types. Fixtures are unobtrusive, too.

Fluoresign Luminaire

Write for Revere's complete catalog of outdoor lighting equipment

Revere ELECTRIC MFG. CO.

OUTDOOR LIGHTING

Revere Electric Mfg. Co. • 7420 Lehigh Avenue • Chicago 31, Illinois

Available in Canada thru Curtis Lighting, Ltd., Leaside, Toronto, Ontario

(*Continued from page 42A*)

Day-Brite Lighting Inc., St. Louis, has announced the election of **Stanley M. Bixler** as senior vice-president and general manager. In this newly created position, he will direct the operation of the sales, finance and production divisions of the firm. Mr. Bixler, who has been vice-president of Day-Brite Lighting Inc. of California will continue to manage this subsidiary. His offices will be at Day-Brite headquarters in St. Louis.

The appointment of Dr. **Maurice H. Bigelow** as vice-president of Barrett Division, Allied Chemical Corp. has been announced. Dr. Bigelow, former technical director of the company, will continue as head of the research and development department. He will make his headquarters in New York.

MMILJ contestants in the Golden Gate Section, at their contest on March 27, were, l. to r.: Conrad Ottoway; Milton Bunker; Robert Haskell, first in Class I; Robert Schwartz, first in Class II; Ed Page; Lloyd Gartner, and Ed Spear.

Horst C. Feige has been named engineering manager, Eastern fluorescent fixture sales for Sylvania Lighting Products. His offices will be at the company's corporate headquarters, 1740 Broadway, New York City. Mr. Feige, who owned one of the largest fixture plants in The Netherlands before it was destroyed in World War II, has been an engineer with Sylvania since 1952.

John C. Virden Co., Cleveland, has announced the election of **Robert W. Minett, Jr.** as vice-president — marketing, and a member of the Board of Directors. Mr. Minett joined the company in 1956 and was most recently director of marketing. **Donald Becker** has been signed by Virden as sales representative for the Central Indiana and Central Illinois areas.

The appointment of **C. A. Reeves,** as vice-president in charge of sales has been announced by the Ripley Co., Inc., Middletown, Conn. Mr. Reeves had been with General Electric Co. for 31 years, serving, most recently, as national utility representative.

Leonard H. Wurzel has been named manager of the Pittsburgh office of Ward Leonard Electric Co., now located at 929 Park Ave., Pittsburgh.

The promotion of **Alvin S. Levine** to manager, lighting sales has been announced by Sola Electric Co., Chicago. Mr. Levine, who has been with Sola for seven years, will be responsible for mercury lamp transformer and fluorescent lamp ballast sales.

Appointment of three division sales managers and three district representatives has been announced by Benjamin Electric Manufacturing Co., Des Plaines, Ill. **Warren J. Prediger,** former assistant division sales manager is now Eastern Division sales manager; **D. M. Woodside** and **Jack A. Chrismer** were named managers of the newly formed Southeastern and Southwestern Divisions, respectively. District representative appointments are: **Warren G. Meltzer,** Massachusetts; **David T. Ostrander,** Ohio and **Eric W. McCabe,** Texas.

Prescolite Manufacturing Co., Berkeley, Calif. has announced three managerial appointments for their new plant in El Dorado, Ark., scheduled to open on July 15. **Charles J. Brown,** who has been associated with the company since 1949 will be plant manager; **Leonard G. Stevens** will serve as plant superintendent and **Robert G. Bennett** will be the office manager. The company also named **Al Thompson** sales representative for the Colorado-Wyoming territory.

K. D. Tobin has been appointed manager of product planning, product service and market research for General Electric's Outdoor Lighting Department. Prior to this promotion, Mr. Tobin served as an application engineer and sales specialist in the Department.

Milton A. Weiner, formerly an executive with Ruby Lighting Corp., Los Angeles, is now affiliated with Western Lighting Corp. of Los Angeles.

Appelton Electric Co., Chicago has opened a West Coast plant and warehouse in Los Angeles. The plant, which will be known as the Appelton Electric Co., Pacific Division, will be headed by **William A. Mundy,** general manager, with **Eugene L. Cherry** in charge of manufacturing. Utah, Nevada and western Texas, as well as the Pacific Coast states, will be served from this new plant.

Leadlight Fixture Co., Oakland, Calif. has announced several additions to their sales force. **John Evans,** formerly with San Diego Gas & Electric Co., has been appointed to the San Francisco area; **Walter Coffman** was named associate to **Lou Black** in the San Diego territory and **Gene Dorman** joins **Oscar Hogenson** in Seattle. **Bruce Emmett** Co. will handle the Leadlight distribution in Portland, Ore.

George T. Howard, formerly with General Electric Co. is now engineering representative for Kliegl Brothers, New York, in Washington, Oregon, Idaho, Montana and southern British Columbia. He will make his headquarters in Portland.

Virgil E. Marshall has joined the Frink Corp., Long Island City, N. Y., as sales representative for Indiana. His office will be located in Indianapolis.

Federal Lighting Corp., Cleveland has announced the signing of **David Dietz, Jr.** as sales representative for the greater Cleveland area and **Russell Korn** as sales correspondent.

Moe Light Division of Thomas Industries, Louisville, Ky. has announced the addition of **H. H. Schwark, Jr.** and **Lee T. Kimmel** to their sales force. Mr. Schwark was formerly sales representative for Bristol-Myers Co.; Mr. Kimmel comes to Moe Light from Marshall Auto Supply of Kansas City, Mo.

Dr. Harold S. Black, Bell Telephone Laboratories, Inc. research engineer,

(*Continued on page 46A*)

WINNERS of the Southern California Section's Allied Arts Competition, present to receive their awards at the April 2 meeting, are: Edward Crane, first, and Gaynor R. Silvera, second. Third place, not shown, was Patrick Porcarello. Contest problem—a restaurant on a narrow downtown lot.

SUSTAINING Member certificate was presented to Don Romanoff, left, proxy for Albert Jassim, President of Lighting Dynamics, Inc. Roy Dahlin, Chairman of the Southern California Section's Sustaining Member Committee, made the presentation, which took place at the April 2 Section meeting.

(*Continued from page 45A*)

whose inventions have made major contributions to long distance and over-seas telephone communications and to the field of electronics, has been awarded the 1957 Lamme Gold Medal by the American Institute of Electrical Engineers. The Medal will be presented to Dr. Black on June 23 at the Summer General Meeting of the society in Buffalo. AIEE has also honored six of its members by confering upon them the grade of Fellow. Those named were: **Howard A. Chinn,** chief engineer, CBS Television, New York; **Joseph B. Epperson,** vice-president—engineering, Scripps-Howard Radio, Inc., Cleveland, Ohio; **Arthur M. Harrison,** Westinghouse Electric Corp., East Pittsburgh, Pa.; **Chester L. Osenbaugh,** director of the Electric Division, Memphis Light, Gas & Water Division, City of Memphis, Tenn.; **Clement S. Schifreen,** research engineer, Philadelphia, Pa. and **Millard C. Westrate,** consulting engineer, Commonwealth Associates, Inc., Jackson, Mich.

Obituaries

Dr. Lawrence A. Hawkins, Fellow Emeritus of I.E.S., died May 15 at the age of 81. Dr. Hawkins had been executive engineer of the General Electric Research Laboratory in Schenectady, N. Y., where he directed development work on many kinds of incandescent, mercury, sodium and fluorescent light sources. He served the Society on numerous technical committees and as a Trustee of the I.E.S. Research Fund. In 1946 he was elected a Fellow of the Society.

Since his retirement from the General Electric Co. in 1947, Dr. Hawkins has been with the Mohawk Development Co., where, at the time of his death, he was chairman of the board.

Walter C. Wagner, long affiliated with the Philadelphia Electric Co., died April 22 at the age of 67.

Mr. Wagner was active not only in the I.E.S., but also in many other organizations serving humanity. He was a member of the United States National Committee of the International Commission on Illumination, attending every annual meeting of the Committee since 1935. In 1951 he was a delegate to the 12th International Sessions of the C.I.E. in Stockholm. As the United States member of the Committee on Voltage Variation and its effect on illumination he rendered excellent service. For several years he was the United States member of the Committee on Lighting Legislation and also served on the Committee on an International Lighting Vocabulary. Also on the international level, Mr. Wagner was the representative from I.E.S. to the International Electrotechnical Commission.

Another of Mr. Wagner's interests was the field of standardization. A member of the Standards Council of the American Standards Association, he was also Vice-Chairman of their Sectional Committee on Revision of the National Safety Code.

Since his retirement in December 1955 from the Philadelphia Electric Co., Mr. Wagner devoted himself to yet another field for contributions—that of air pollution control. As an expert on smog, he served as technical advisor for the Air Pollution Control Committee of the Chamber of Commerce of Greater Philadelphia. It was expected that he would become the first president of the International Commission on Air Pollution, which is now in the process of organization, in part due to Mr. Wagner's efforts.

Mr. Wagner was a Fellow of the American Institute of Electrical Engineers, a member of the American Industrial Hygiene Association, and was active in the Franklin Institute.

Robert B. Burton, Sr., Member Emeritus of the Society, died recently at the age of 85.

Mr. Burton had served the Society continuously for nearly fifty years, having joined in 1910. Throughout the years, he was an active member of his local Section, whether in New England or in Chicago. He regularly attended both Regional and National Conferences.

A member of the I.E.S. Historical Committee since it was first appointed in 1951, he had a remarkable collection of historical pictures of people and lighting equipment, which was shown at the Golden Anniversary Conference in 1956.

As a personal contribution to the "dissemination of knowledge of the theory and practice of illuminating engineer-

(*Continued on page 48A*)

THESE DAYS... WHEN AN ENGINEER AND A CONTRACTOR GET TOGETHER AND TALK FIXTURES...

Luminous Ceilings

Ceiling Modules

Recessed Coffers

Recessed Troffers

Surface Mounted

Pendant and Flush

COLUMBIA'S NEW KOLDBOND

½" x ½" x ½"

COLORED LOUVER ALWAYS COMES UP!

The aluminum ½"x½"x½", available in many different colors and shades (even matched to specification), coupled with the natural advantages of small-cell shielding, has opened up an all-new vista in illumination design. With the lowest brightness factor of any shielding medium and rugged one-piece assembly by the Koldbond process easily removed for maintenance, it's no wonder the Columbia ½"x½"x½" is the most talked about louver in the industry today... now that color has been added.

TO JOIN IN THE CONVERSATION, SEND FOR FULL INFORMATION AND A SET OF FREE COLORED SAMPLES TODAY.

COLUMBIA ELECTRIC & MANUFACTURING CO.

N. 2310 Fancher Way Dept. I-6 Spokane 10, Washington

(*Continued from page* 46A)

ing," Mr. Burton presented to his local library in Oak Park, Ill., complete bound volumes of ILLUMINATING ENGINEERING and a copy of each new edition of the *IES Lighting Handbook*.

Deaths

John R. Chaffer, Puget Sound Section
Charles W. Johnson, Georgia Section
William A. Newman, Inland Empire Chapter
Thomas Whalen, Rochester Section

BOOKS AND PAMPHLETS

Heating, Ventilating, Air Conditioning Guide, 36th Edition, published by American Society of Heating and Air-Conditioning Engineers, 62 Worth Street, New York 13, N. Y., 1775 pp., $12.00.

The 1958 edition of this annual guide, including both a Technical Data Section and a Catalog Data Section, is now available from ASHAE headquarters.

Our Streets Can Be Beautiful — and Useful, Vol. II, Proceedings of the Second Street Tree and Utility Conference held in Cleveland, Ohio, March 7-8, 1957. 160 pages, 48 illustrations. Price: 1-9 copies, $2.55; 10-49 copies, $1.85; 50-99 copies, $1.60; 100-499 copies, $1.30; 500 or more, $1.15. Available from the Edison Electric Institute, 750 Third Ave., New York 17, N. Y.

Program for this second Conference presented speakers from organizations responsible for trees, street lighting and utility services as well as representatives from such groups as the American Institute of Planners, the American Society of Landscape Architects, the National Association of Home Builders and the American Association of Nurserymen. This book contains the papers presented and the discussion which developed at the meeting.

RLM Standard Specifications Book, 1958 Edition, published by the RLM Standards Institute, 326 W. Madison St., Chicago 6, Ill., no charge.

The latest edition of this reference guide designed for those concerned with purchasing, specifying or selling industrial lighting is now available. New specifications included in the 1958 revision are: 2-lamp and 3-lamp special service fluorescent units, 3 types of units utilizing 800 ma fluorescent lamps, new incandescent reflector sizes and new mounting specifications for fluorescent units.

Your Guide to NEMA Standards Publications, 1958 Edition, published by National Electrical Manufacturers Association, 155 East 44th St., New York 17, N. Y., 17 pp., no charge.

This booklet, describing the 150 Standards publications developed by subdivisions of NEMA and including a price list for all NEMA publications, is now available from NEMA headquarters.

Farm Electrification Catalog of Visual Aids, available from Commercial Division, Edison Electric Institute, 750 Third Ave., New York, N. Y., 14 pp.

The Farm Development Committee of EEI has published a catalog of movies and slides available for the promotion of greater use of electricity on farms. 41 movies and 12 film strips and slides which deal with farm electrification are listed, along with a brief resume, price and "where-to-obtain" information for each.

Price per copy is 50 cents for orders of one to five booklets, and 35 cents each for orders of more than five.

Why Do Prospects Buy?, 58-1, available from Commercial Department, Edison Electric Institute, 750 Third Ave., New York, N. Y., 27 pp.

This illustrated booklet has been prepared by the Commercial Lighting Committee of the Edison Electric Institute as an aid to electric utility companies in the promotion of commercial lighting. It reviews and analyzes the motives which influence buying and enumerates the various types of lighting which can be utilized in commercial establishments. The final chapter deals with case histories, demonstrating how good lighting helped to build sales in eight different kinds of commercial establishments.

Cost to EEI member companies is $1.00 per copy for less than five copies, or $.50 each in quantities over five. Cost to non-members and those outside the U.S.A. is 10 per cent additional.

Summary Report of National Electrical Week, February 9-15, 1958 is available from the National Electrical Week Committee, 290 Madison Ave., New York 17, N. Y.

NEW MEMBERS

On recommendation of the Board of Examiners, the following were elected to membership on May 8. Names marked * are transfers from Associate Member Grade. Names marked ** are transfers from Student Member Grade.

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Fullilove, A. B., Jr., Sale Electric Supply, Inc., Shreveport, La.
Huddleston, J. M., Frey-Huddleston & Associ-

(*Continued on page* 54A)

ANNUAL extension trip of the Milwaukee Section, April 17, was to tour the facilities of the Chicago Lighting Institute. Three buses carried 85 I.E.S. members and guests on the trip.

With no change in tube shape or size, new Sylvania **VHO** delivers as much light as 2½ standard fluorescent tubes

VHO means Very High Output

Another reason why

Sylvania Fluorescents give you more light at lower cost than all other brands

No other very high intensity fluorescents cost so little to buy and use – or maintain greater brightness throughout lamp life. The new VHO fluorescent lamp looks like any standard lamp—yet it delivers more than 2½ times as much light as lamps of identical size and shape. The initial cost of Sylvania VHO is appreciably lower than any other high intensity fluorescent lamps, and at no sacrifice in service or performance. VHO lamps keep operating costs to a minimum by giving you more effective, useful light than other high intensity fluorescent lamps.

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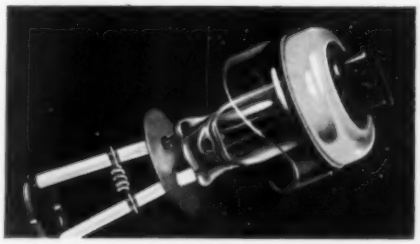

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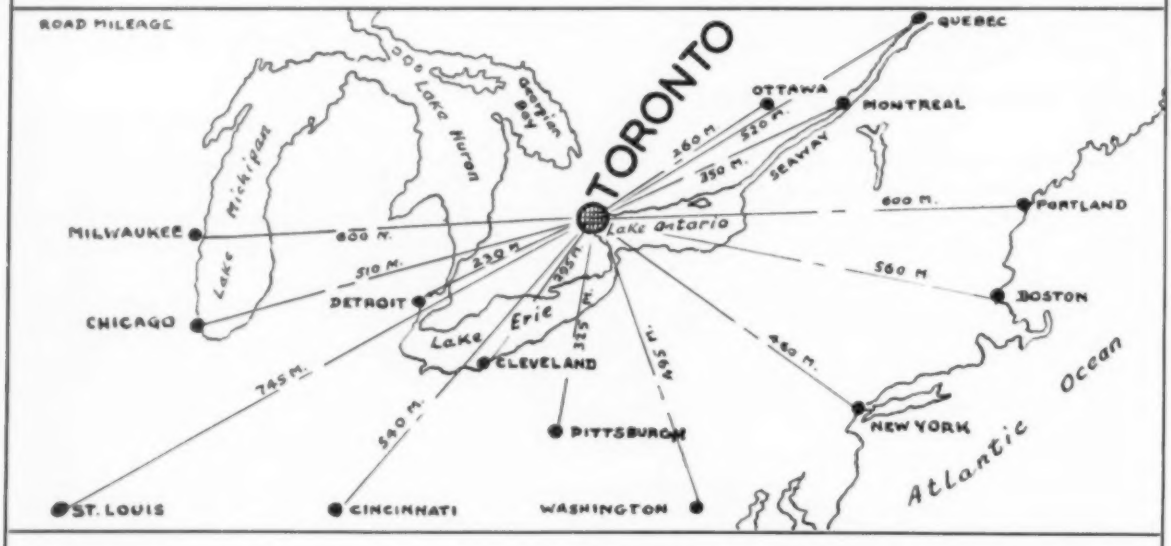

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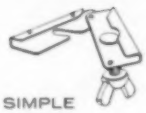

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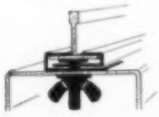

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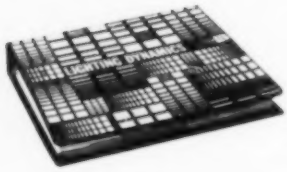

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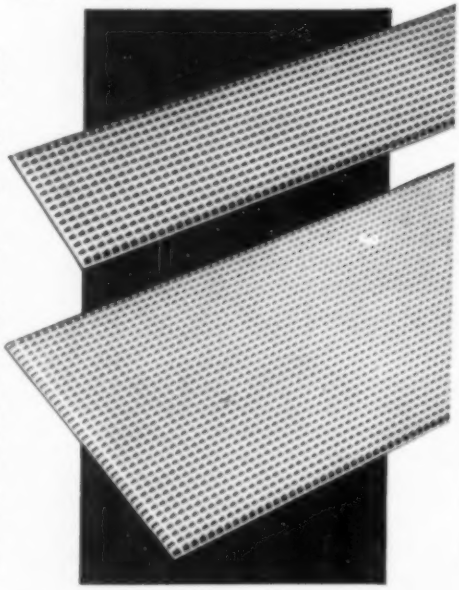

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(Continued from page 48A)

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(*Continued on page* 56A)

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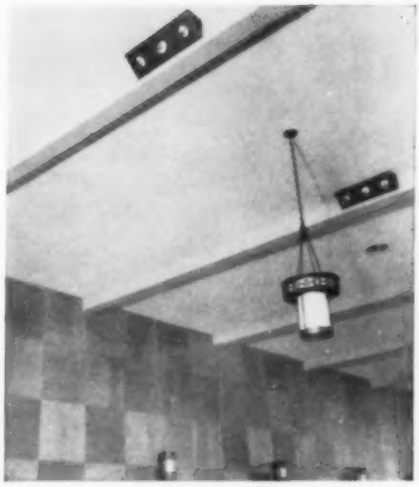

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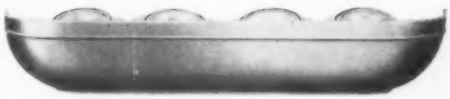

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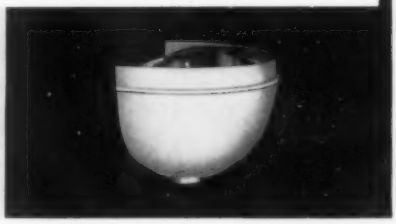

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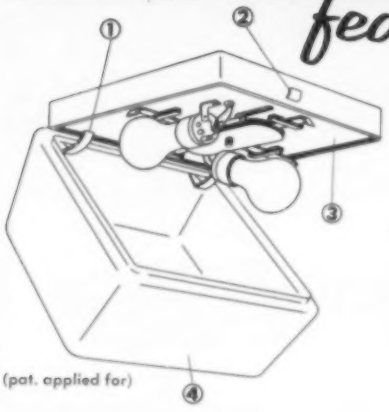

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(*Continued on page* 59A)

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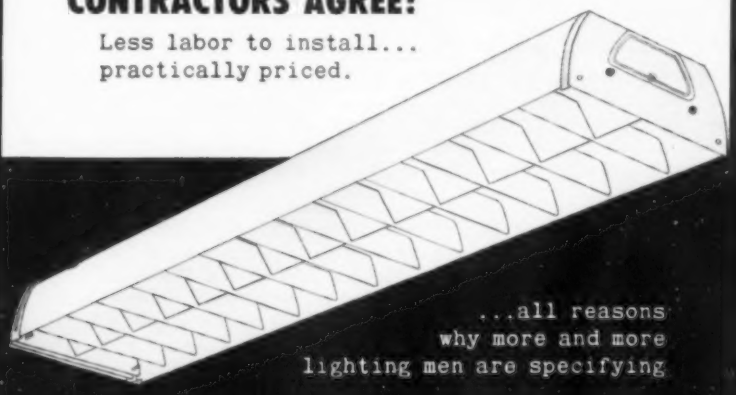

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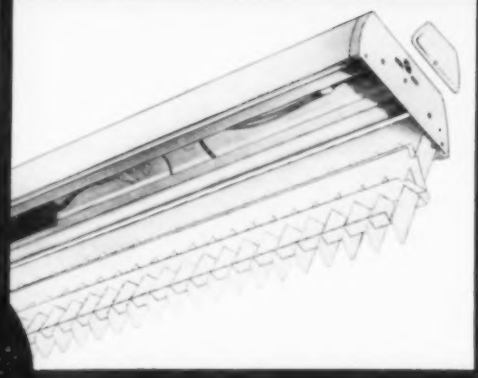

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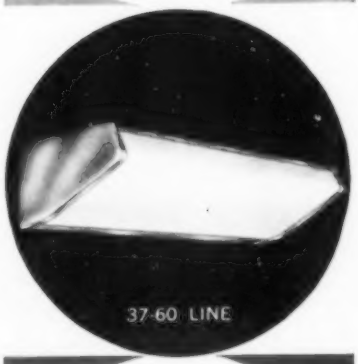

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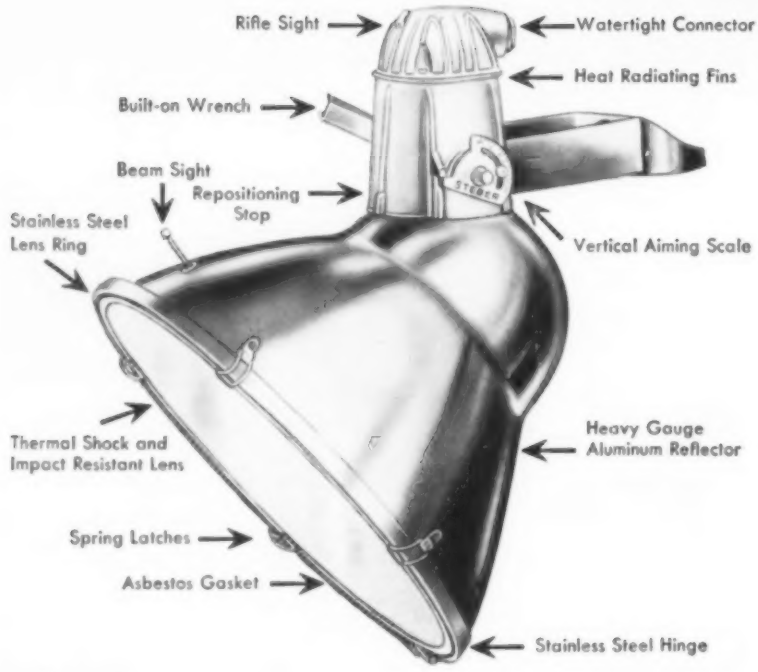

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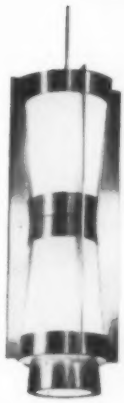

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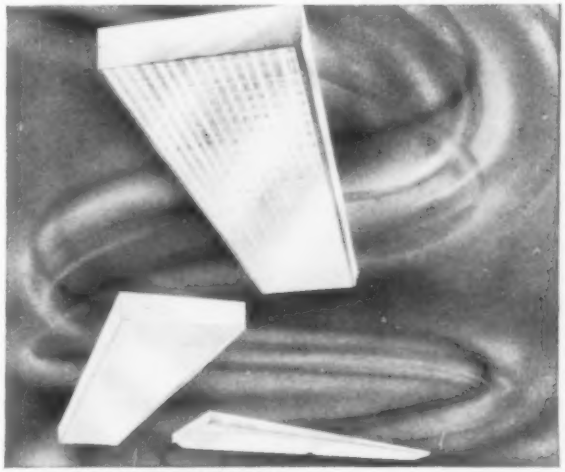

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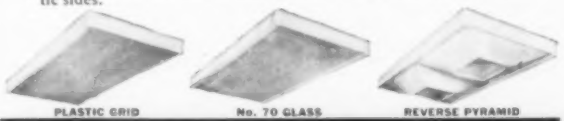

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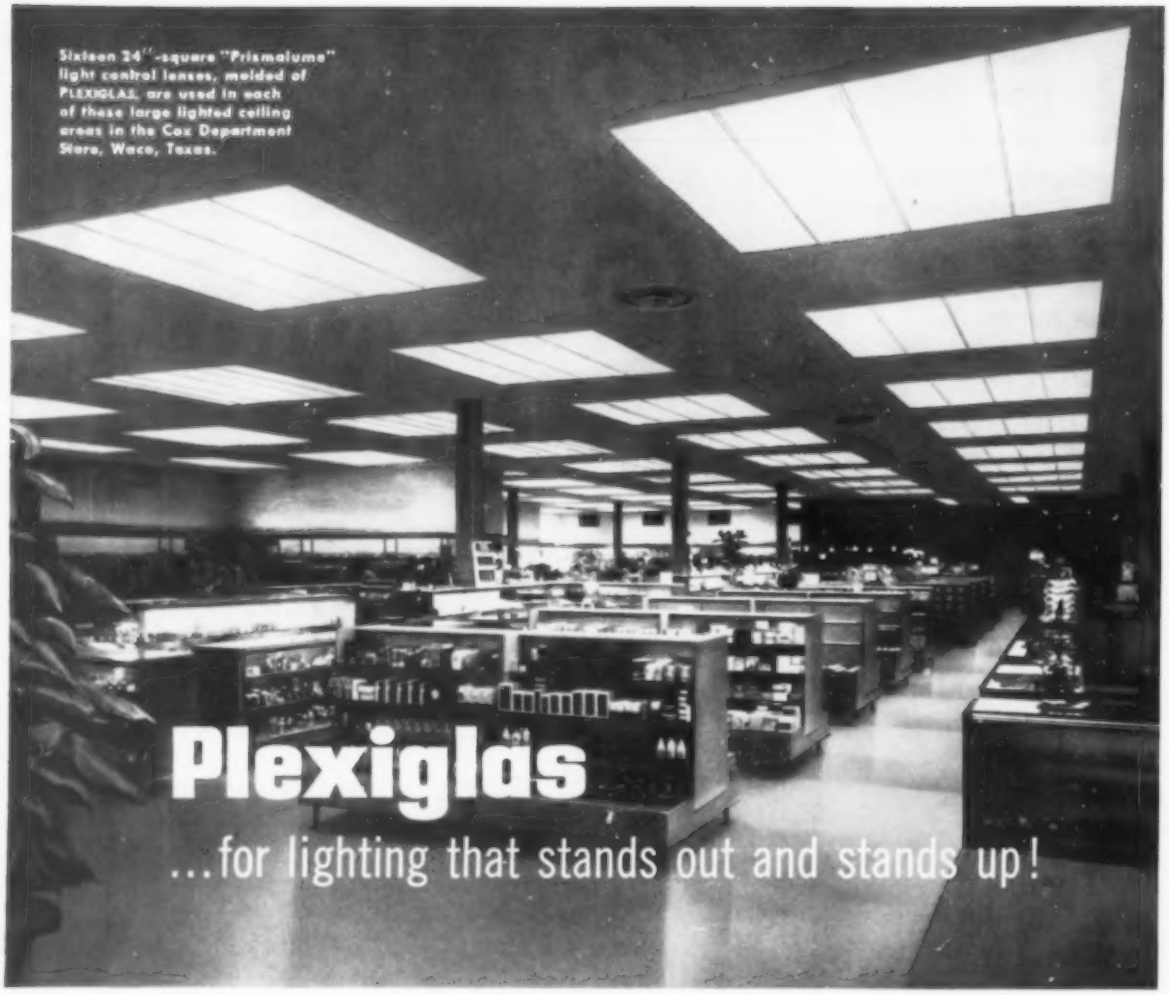
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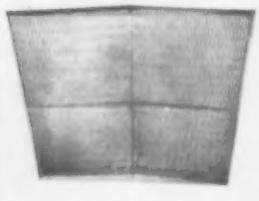

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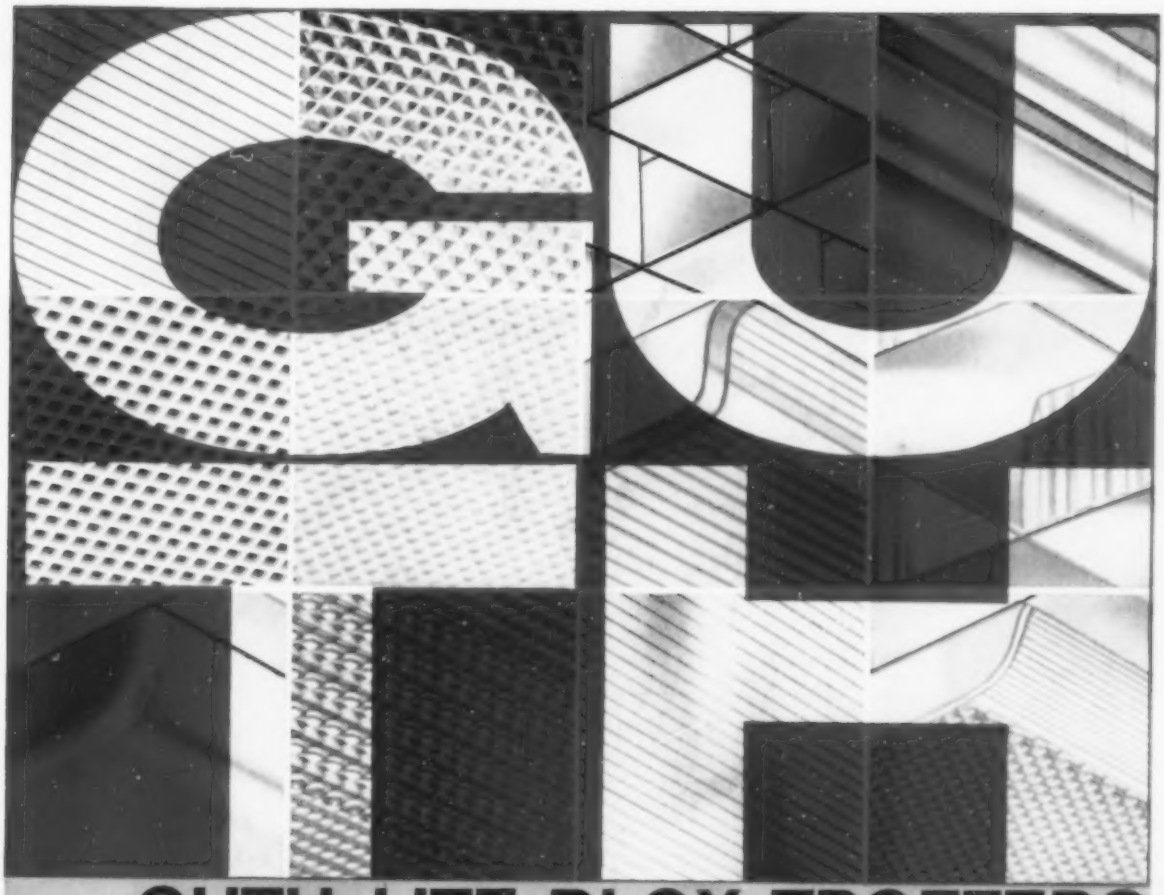

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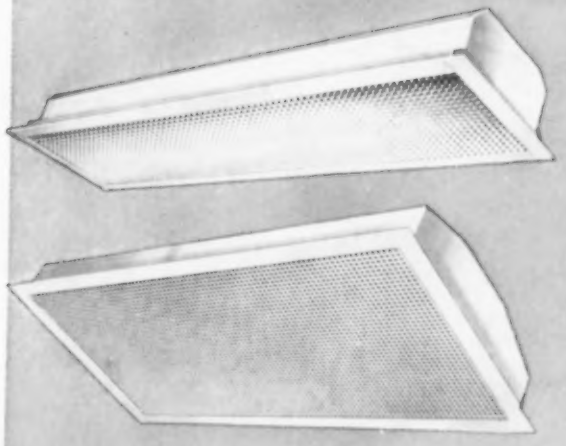

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